CHAPTER 2

CANOPY SYSTEMS

Terminal Objective: Upon completion of this chapter, you will be able to identify the types of canopy systems; recognize cartridge and cartridge-activated devices (CAD), service life, and expiration dates; identify CAD maintenance policy; and identify the reason for the ordnance certification program.

The canopy on modern high-performance aircraft serves several purposes. It protects the crew, provides enhanced visibility, and serves as an avenue of escape in case of emergency.

The canopy system includes the canopy itself, plus all the components used in opening and closing the canopy for normal entrance and exit, as well as those used in jettisoning the canopy during an emergency. Inspection and maintenance of canopy actuating systems are important responsibilities of the AME.

Three types of canopies are present on naval aircraft. Two types of canopies—the clamshell type and the sliding type—are commonly used on naval aircraft. The clamshell type used on the F-14 aircraft is hinged aft and opens at the forward end like a clamshell. The sliding type used on the A-6 aircraft rests on tracks on the fuselage and opens and closes by a sliding action. Figure 2-1 illustrates these two types of canopies. A third canopy type, the frangible canopy, is less common, is used on the S-3 aircraft, and has many unique features. All three types will be presented in this chapter.

Aircraft manufacturers have designed various methods of actuating the canopy. Normal opening and closing may be accomplished pneumatically (compressed air), electrically, manually, or hydraulically. Emergency opening (jettisoning) is done pneumatically or explosively.

In most instances, more than one method is provided for normal opening and closing of the canopy; thus, if one system fails, the other may be used. The same holds true for jettisoning the canopy.

CLAMSHELL CANOPY SYSTEM

Learning Objective: Identify the types of canopy systems and their purpose; recognize the function, operation, and purpose of the components in the F-14 aircraft canopy system.

The clamshell canopy is a transparent cockpit enclosure consisting of two acrylic panels in a metal frame. During normal operation, a

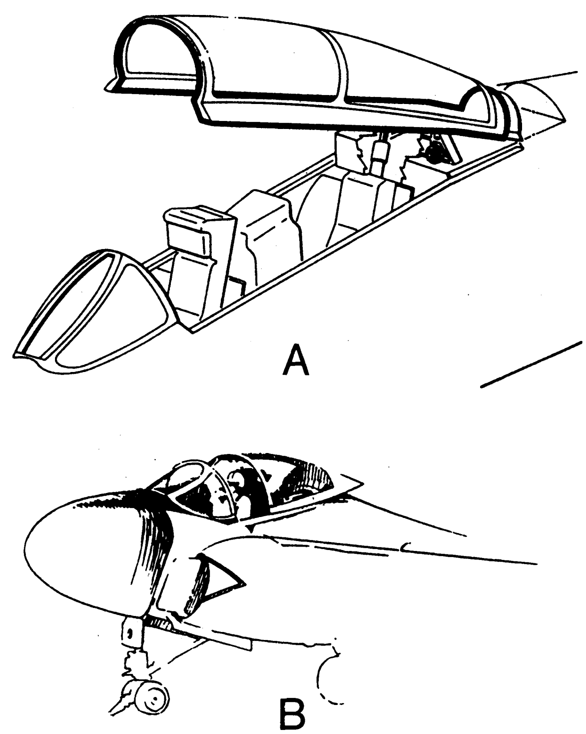

Figure 2-1.—Types of canopies. (A) clamshell (B) sliding.

pneumatically controlled canopy hydraulic actuator opens and closes the canopy. A canopy-lock pneumatic actuator moves the canopy to the locked or unlocked position. The canopy is locked in the closed position by locking hooks that engage latches on the cockpit sill. An inflatable rubber seal in the canopy frame forms a pressure-tight enclosure when the canopy is closed and locked. Three rearview mirrors are mounted on the pilot's forward canopy frame and one on the naval flight officer's (NFO) forward canopy frame. The canopy can be jettisoned for an emergency on the ground and during the ejection sequence.

The clamshell canopy pneumatic system provides normal opening and closing of the canopy. The system is controlled with the canopy control handle at each crew station or with the external canopy control handle on the fuselage left side. Pneumatic pressure from externally serviced reservoirs supply the power for the different modes of canopy operation. The canopy can also be manually opened and closed. A reference mark is painted on the fuselage and canopy, and when the canopy is closed and locked, the marks are aligned.

SYSTEM OPERATION

The F-14 aircraft uses the clamshell canopy system. This pneumatic system is operated by setting any one of the three canopy control handles, This action positions valves within the pneumatic control module to route pneumatic pressure to or from the system. The modes of operation that can be selected are normal opening mode, holding mode, normal closing mode, boost closing mode, and auxiliary opening mode. The function of all three control handles is the same.

Normal Opening Mode

Figure 2-2 (a foldout at the end of this chapter) shows a schematic of the F-14 pneumatic canopy system. Setting the pilot canopy control handle to open pulls the lock lockpin and positions valves No. 1,2, and 6 within the control module to direct nitrogen at 325 psi through the C 1 and C3 ports of the module, to the timer check valve, and to the unlock port of the canopy-lock pneumatic actuator. Simultaneously, the shutoff valves in the open and close modules of the canopy hydraulic actuator are vented to the atmosphere through the C5 port of the actuator, through the canopy pneumatic timer, and through valve No. 3 in the control module. The lock port of the canopy-lock pneumatic actuator is vented overboard through the pneumatic timer. The piston of the actuator extends and, by means of a torque tube, cranks, and links, moves the canopy aft to unlock it from the sill locks. When the extending piston reaches the end of its stroke, ball locks engage to hold it in that position. The extended piston also actuates the timer check valve, which directs the 325-psi nitrogen to the C1 port of the canopy hydraulic actuator. The nitrogen that enters the hydraulic actuator acts against the piston of the open transfer cylinder. This pressure, acting against the piston, causes the hydraulic fluid on the opposite side of the piston to extend the actuator. The extending actuator rotates the canopy on the aft hinge to open the canopy. As the actuator extends, fluid displaced from the close side of the actuator acts against the piston of the close transfer cylinder. The nitrogen on the opposite side of this piston is vented overboard through the C2 port of the hydraulic actuator and through valve No. 4 of the control module. Pulling the lock lockpin at the beginning of the opening cycle closes the canopy switch, which provides 28 volts from the essential dc No. 2 bus, through the CAN/LAD CAUTION/EJECT CMD IND circuit breaker, to the canopy caution indicator light on the pilot and NFO caution advisory indicators.

Holding Mode

The HOLD position stops canopy motion at any desired opening. Valve No. 3 in the control module directs 325-psi nitrogen through the C5 port of the module, through the pneumatic timer, to the C5 port of the hydraulic actuator. The nitrogen that enters the C5 port closes the shutoff valves in the open and close modules. The closed shutoff valves trap hydraulic fluid on the open and close side of the actuator piston, stopping piston travel.

Normal Closing Mode

Setting the control handle to CLOSE positions valves No. 1, 2, 4, and 5 in the control module to vent both transfer cylinders and the unlock port of the canopy-lock pneumatic actuator overboard. The weight of the canopy closes it; pneumatic power is not required. The closing time, approximately 10 seconds from the fully open position, is controlled by the flow regulators in the open and close control modules of the hydraulic actuator. The final closing motion of the canopy actuates the pneumatic timer to direct 325-psi nitrogen from valve No. 2 of the control module to the lock port of the canopy-lock pneumatic actuator, unlatching the ball locks. The actuator piston retracts and, by reverse action, moves the canopy forward to engage the canopy hooks in the sill locks. With the canopy in its full forward positions, the lock lockpin engages and prevents aft movement of the canopy. The final motion of the lock lockpin opens the canopy switch, breaks the circuit to the canopy caution indicator light on the caution advisory indicators, and the lights go off.

Boost Closing Mode

To close the canopy under high headwind conditions, the canopy control handle must be moved to BOOST. On aircraft not modified by AFC 95, the control handle must be rotated outboard to move the handle pasta stop to BOOST. Valve No. 4 in the control module is positioned to direct 790-psi nitrogen through the C2 port of the canopy hydraulic actuators to the close transfer cylinder. This nitrogen, acting against the transfer cylinder piston, causes the hydraulic fluid on the opposite side of the piston to retract the actuator. The other valves in the control module are positioned the same as when CLOSE is selected, and the system functions in the same manner to lock the closed canopy. The closing time for this mode of operation is also controlled by the flow regulators in the open and close control modules of the hydraulic actuator.

Auxiliary Opening Mode

The auxiliary opening mode is used to unlock the canopy when normal pneumatic system reservoir pressure drops below 225 psi. To prevent further depletion of nitrogen pressure in the normal system, a low-pressure sensor repositions valves No. 5 and No. 6 in the control module. The canopy must now be unlocked by activating the auxiliary opening mode. To set the canopy control handle to AUX OPEN on aircraft not modified by AFC 95, the handle must be rotated outboard to move past a stop (the handle will remain in the AUX OPEN position). When the control handle is set to AUX OPEN, the auxiliary unlock pneumatic release valve releases pressurized nitrogen from the auxiliary pneumatic reservoir. Nitrogen pressure from this reservoir flows through a 325-psi pressure reducer, through the release valve and pneumatic unlock shuttle valve, to shift position of the shuttle valve internal spool. This directs nitrogen pressure to the unlock port of the canopy-lock pneumatic actuator, unlocking the canopy. Valve No, 1 in the control module directs reservoir pressure to the open transfer cylinder of the canopy hydraulic actuator. This low-pressure nitrogen, acting against the transfer cylinder piston, counterbalances the weight of the canopy. The canopy can then be easily opened and closed manually. The canopy cannot be locked closed under these conditions. To return the system to normal operation, the control handle must be set to OPEN and, on aircraft not modified by AFC 95, rotated outboard to move past a stop. The release valve eccentric cam must be manually reset to block auxiliary nitrogen pressure flow to the shuttle valve and to vent the pressure in the canopy-lock pneumatic actuator.

SYSTEM COMPONENTS

The purpose of each of the major components of the F- 14 clamshell canopy system is presented in the following paragraphs. Refer to figure 2-2 to see how each component fits into the overall system.

Canopy Hydraulic Actuator

The canopy hydraulic actuator opens and closes the canopy. It consists of a double-acting hydraulic cylinder, two transfer cylinders, and two hydraulic control modules. The transfer cylinders convert pneumatic pressure from the canopy pneumatic control module to hydraulic power. The hydraulic control modules contain pneumatically actuated shutoff valves that hydraulically lock the canopy actuator in any position when the canopy pneumatic control module is in the neutral position. Flow regulators control actuator speed by permitting free flow of hydraulic fluid to the actuator and restricted flow from the actuator. Thermal relief valves relieve pressure from the double-acting cylinder to the transfer cylinders. The canopy hydraulic actuator is accessible from the NFO station when the canopy is opened and the NFO ejection seat is removed.

Canopy-Lock Pneumatic Actuator

The canopy-lock pneumatic actuator locks and unlocks the canopy. It operates with nitrogen pressure from the canopy pneumatic control module and the canopy pneumatic timer. The actuator moves the canopy forward or aft to the RETR (locked) or EXT (unlocked) position, respectively. When the actuator piston reaches its full EXT (unlock) travel limit, the timer check valve permits pneumatic pressure flow from the canopy pneumatic control module to the open side of the canopy hydraulic actuator. While the canopy closes, the timer check valve vents pneumatic pressure from the canopy hydraulic actuator through the canopy pneumatic control module. When the canopy-lock pneumatic actuator piston moves toward the RETR (locked) position, the timer check valve reseats.

Lock Actuator Restrictors

The lock actuator restrictors regulate the speed of the canopy-lock pneumatic actuator during canopy locking and unlocking.

Canopy Pneumatic Timer

The canopy pneumatic timer permits pneumatic pressure flow from the canopy pneumatic control module to the lock side, of the canopy-lock pneumatic actuator and vents or pressurizes the canopy hydraulic actuator shutoff valves. The last closing motion of the canopy actuates the timer.

Canopy Pneumatic Control Module

The canopy pneumatic control module regulates pressure from the canopy pneumatic reservoir and directs it to the canopy pneumatic timer, timer check valve, canopy hydraulic actuator, and canopy-lock pneumatic actuator. The module contains a filter, restrictor, two pressure reducers, two relief valves, low-pressure sensor, and control valves. If canopy pneumatic reservoir pressure drops below 225 psi, the low-pressure sensor causes the module valves to lock the remaining pressure in the canopy hydraulic actuator to counterbalance the weight of the canopy. This allows manual opening and closing of the canopy. Canopy unlocking is accomplished by the auxiliary unlock mode.

Canopy Pneumatic Reservoir

The reservoir stores high-pressure dry nitrogen for operation of the canopy pneumatic system. The reservoir is serviced to 3,000 psi; it has a 225-cubic-inch capacity. Servicing is accomplished through the pneumatic servicing charging module, which is remote from the reservoir.

Reservoir Check Valve

The reservoir check valve is in the servicing line to the canopy pneumatic reservoir. The valve prevents nitrogen flow from the reservoir to the pneumatic servicing charging module.

Reservoir Relief Valve

The reservoir relief valve, on the canopy pneumatic reservoir, prevents overpressurization of the reservoir. The valve opens at 4,500 psi and reseats at 4,100 psi.

Pneumatic Servicing Charging Module

The pneumatic servicing charging module is in the nosewheel well. This module contains a filler valve, filter, two check valves, and two pressure gauges. The filler valve allows filling both the canopy pneumatic reservoir and the emergency landing gear reservoir from a single point. The check valves prevent reverse flow when one reservoir has a lower pressure than the other.

Canopy Switch

The canopy switch is actuated by the canopy locking mechanism lock lockpin; the switch closes when the canopy unlocks. This completes a circuit to the canopy caution indicator light on the pilot and NFO CAUTION ADVISORY indicators. When the canopy locks, the switch opens.

Auxiliary Pneumatic Reservoir

The auxiliary pneumatic reservoir, aft of the canopy, has a 14.6-cubic-inch capacity. It stores high-pressure dry nitrogen for unlocking the canopy in the auxiliary mode. The reservoir is serviced, through a filler manifold, to 3,000 psi.

Auxiliary Pneumatic Reservoir Filler Manifold

The auxiliary pneumatic reservoir filler manifold is connected to the auxiliary pneumatic reservoir. It consists of a nitrogen filler valve and pressure gauge.

Auxiliary Pneumatic Reservoir Relief Valve

The auxiliary pneumatic reservoir relief valve, adjacent to the auxiliary pneumatic reservoir, is connected to the reservoir outlet port. It is a spring-loaded poppet valve that prevents overpressurization of the auxiliary pneumatic reservoir. Valve cracking pressure is 4,500 psi; full flow occurs at 5,100 psi. The valve reseats when the auxiliary pneumatic pressure drops to 4,100 psi.

Auxiliary Pressure Reducer

The auxiliary pressure reducer, located downstream of the auxiliary pneumatic reservoir, reduces pneumatic pressure (to 325 psi) applied to the auxiliary unlock pneumatic release valve.

Auxiliary Unlock Pneumatic Release Valve

The auxiliary unlock pneumatic release valve, aft of the canopy, is a lever-operated shutoff valve that is connected by a cable-and-pulley assembly to the canopy control handle in the pilot and NFO stations. It is a two-position valve operated by an eccentric cam mechanism and detented to maintain the open position. An internal vent releases pneumatic pressure when the auxiliary mode is not selected. When the auxiliary mode is selected to unlock the canopy, the vent port is blocked to permit pneumatic pressure application to the unlock shuttle valve. After each auxiliary mode operation, the cam must be reset manually to return the system to normal.

Unlock Shuttle Valve

The unlock shuttle valve, aft of the canopy, is a three-port, pressure-operated valve. An internal spool is shuttled by pneumatic pressure at either end of the valve housing to block one of the two end inlet ports. When the canopy control handle is moved to the OPEN position, pneumatic pressure flows from the canopy pneumatic control module, through the shuttle valve and the unlock actuator restrictor, to the unlock side of the canopy-lock pneumatic actuator. In the auxiliary mode (AUX OPEN), auxiliary pneumatic pressure shuttles the valve spool in the opposite direction to route auxiliary pneumatic flow from the auxiliary unlock release valve to the unlock end of the canopy-lock pneumatic actuator.

EMERGENCY CANOPY JETTISON SYSTEM

The emergency canopy jettison system (fig. 2-3) jettisons the canopy clear of the cockpit

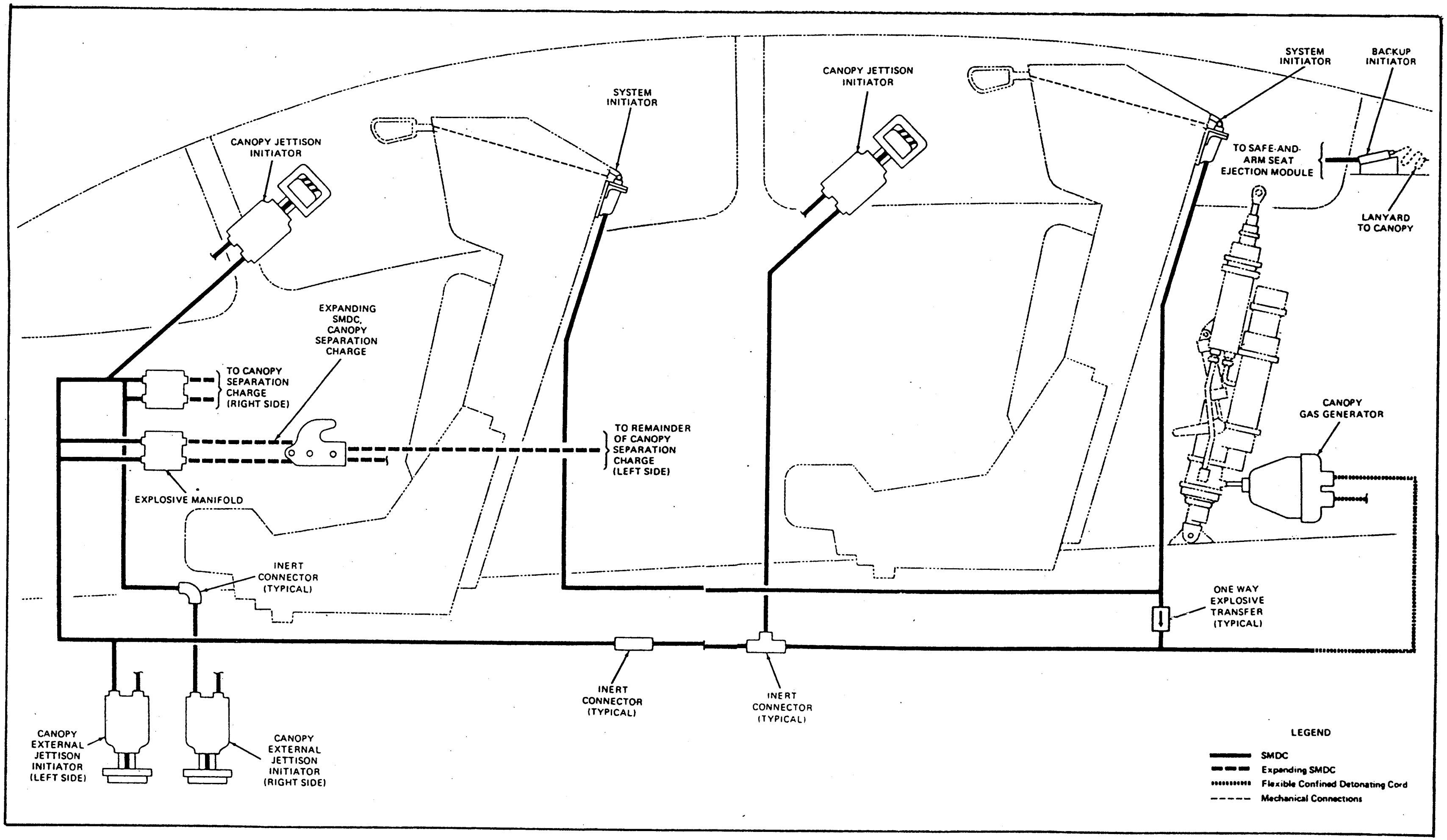

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Figure 2-3.—Canopy emergency jettison system.

during emergency conditions that require emergency ground egress, seat ejection, or ditching. The canopy must be clear of the cockpit before seat ejection. Through the use of pyrotechnics, the canopy is automatically unlocked and jettisoned when seat ejection is initiated. The canopy may be jettisoned without initiating seat ejection by pulling a canopy emergency jettison initiator handle (fig. 2-4), located inside the aircraft or externally (fig. 2-5) on either side of the aircraft.

System Operation

Pulling the pilot or NFO face curtain or secondary firing control handle initiates seat ejection (fig. 2-3). A system initiator is fired by sear removal. This sends an explosive signal through shielded mild detonating cord (SMDC) lines to the safe-and-arm firing pins, canopy-separation charge expanding SMDC, and canopy gas generator. Expanding SMDC lines, routed through the latch hooks, break the canopy latch frangible bolts and allow the hooks to rotate upward, releasing the canopy.

The canopy gas generator produces high-pressure gas that forces the canopy hydraulic actuator shaft upward, ballistically jettisoning the canopy. As the canopy leaves the aircraft, the lanyard for the backup initiator becomes taut and actuates linkage to remove the backup initiator sear. This fires the initiator to send an explosive signal through a 1.1-second time delay. This signal positions an explosive charge within

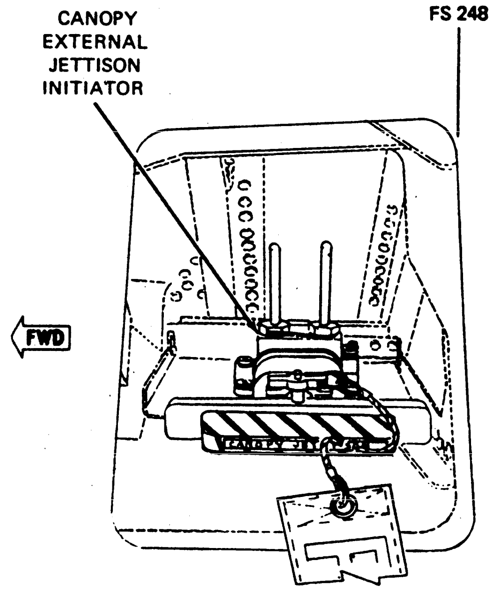

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Figure 2-5.—Canopy external jettison initiator handle.

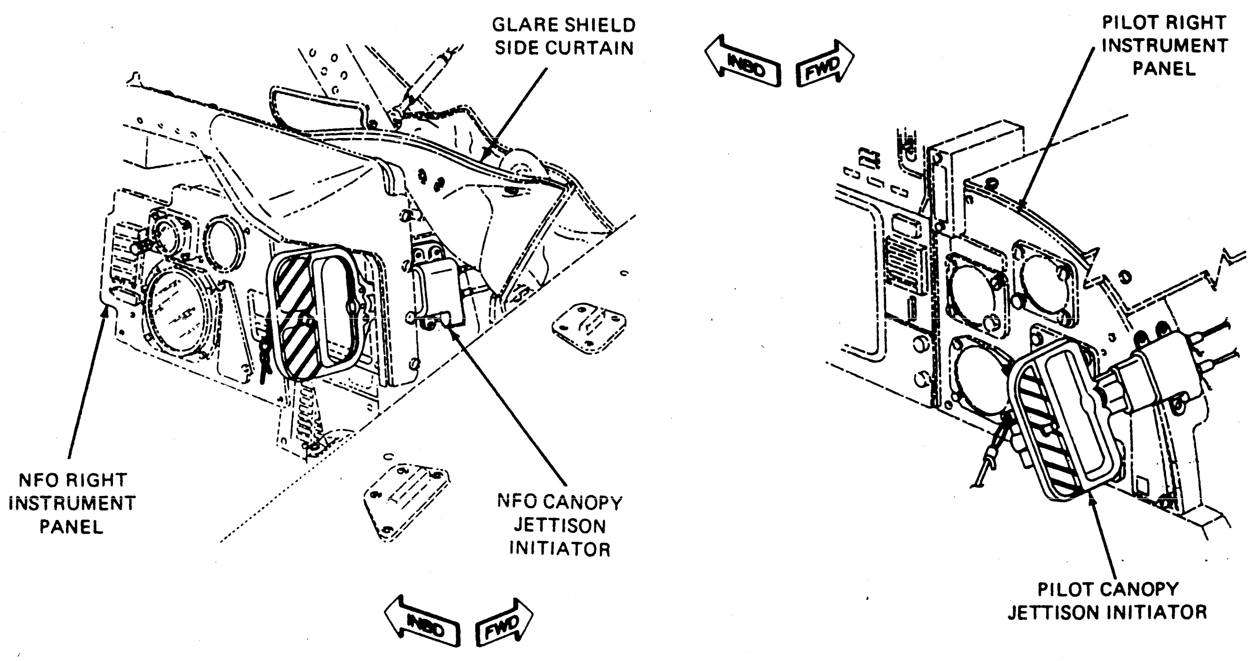

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Figure 2-4.—Canopy emergency jettison initiator handles.

the safe-and-arm seat ejection module for use if the lanyard-operated firing mechanism of the module fails.

As previously mentioned, during emergency ground egress, seat ejection, or ditching conditions, the canopy may be jettisoned by pulling either an internal or external canopy emergency jettison initiator handle. During emergency ground egress, without seat ejection, the explosive signal provided by the canopy jettison initiator is blocked from entering the SMDC lines of the seat ejection system by the one-way explosive transfers. Inert connectors joining the SMDC lines transfer the explosive stimuli through bulkheads, straight runs, tee connections, and 90-degree bends. Explosive manifolds, within SMDC line runs, allow output SMDC lines to be initiated from one SMDC input. This assures system redundancy by providing dual-line initiation for the canopy-separation charge.

Canopy Jettison Initiators

Two canopy jettison initiators enable the aircrewman to jettison the canopy during emergency conditions, without initiating seat ejection. The canopy may be jettisoned by pulling the canopy emergency jettison initiator handle on either the pilot's or NFO's right instrument panel.

Canopy External Jettison Initiators

Canopy external jettison initiators enable the ground crew to jettison the canopy during ground emergency conditions. Each initiator is manually actuated by pulling its canopy external jettison initiator handle.

System and Backup Initiators

The system has two system initiators and one backup initiator. One system initiator is located behind each ejection seat. These initiators are actuated by pulling the face curtain or secondary firing control handle. They provide the initial explosive signal for canopy jettison and seat ejection. The backup initiator is on the cockpit turtle deck. This initiator performs a backup function for the safe-and-arm seat ejection module. It is actuated by a lanyard attached to the canopy and the initiator sear linkage. As the canopy is jettisoned, the lanyard actuates linkage to remove the sear and fire the initiator, sending an explosive signal through a 1.1-second time delay to the safe-and-arm module.

Canopy Gas Generator

The canopy gas generator is attached to the lower end of the canopy hydraulic actuator. The canopy gas generator provides high-pressure gas to the actuator, to jettison the canopy.

Inert Connectors

Inert connectors installed throughout SMDC line runs permit interconnection of the SMDC lines.

Explosive Manifolds

Explosive manifolds installed within SMDC line runs incorporate an internal explosive crossover that permits either SMDC to fire both output SMDC lines. The manifolds also provide structural support for mounting the SMDC lines to the aircraft structure.

One-Way Explosive Transfers

One-way explosive transfers installed within SMDC line runs provide unrestricted explosive transfer in one direction only. If an explosive signal is introduced in the opposite direction, it is blocked.

SLIDING CANOPY SYSTEM

Learning Objective: Recognize the operation, emergency jettison procedures, and components of the sliding canopy system.

An example of the sliding canopy system is found on the A-6 aircraft. The A-6 cockpit is covered by a sliding canopy powered by a canopy system consisting of the components required for normal operation and emergency jettison of the canopy. The entire system is hydraulically operated with the exception of the jettison device. The A-6 uses a pneumatic jettison concept. Hydraulic power for operation of the system is furnished by the combined (both engines) hydraulic system or the hand pump system (fig. 2-6).

SYSTEM OPERATION

Hydraulic flow to open or close the canopy is controlled through a canopy selector valve, which is in the nosewheel well under the cockpit

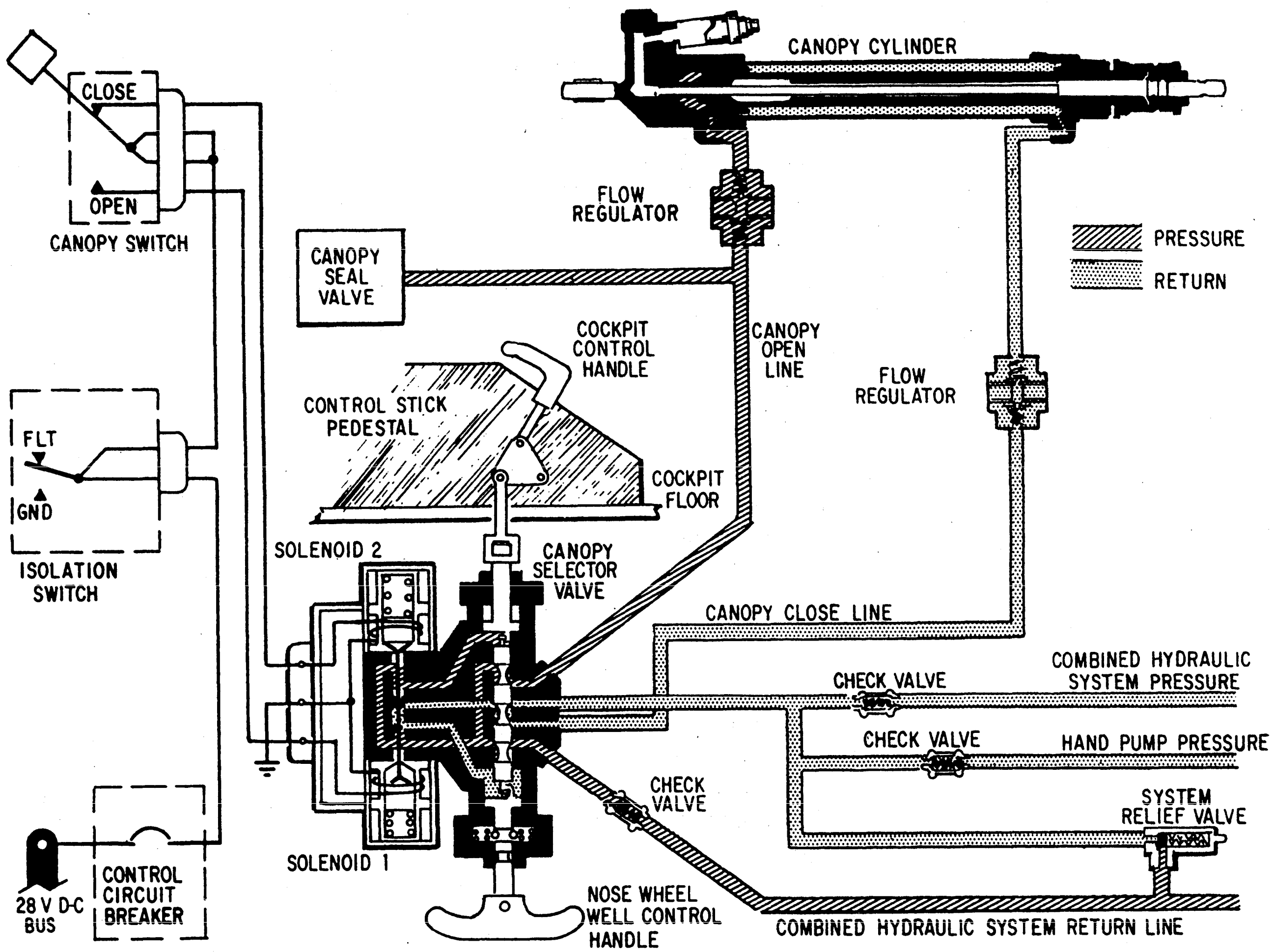

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Figure 2-6.—Hydraulic canopy operation.

floor. This selector valve may be operated either electrically or manually from the cockpit or the nosewheel well. Normal operation is electrical through the canopy switch on the pilot's instrument panel. This switch controls the selector valve whenever the engines are operating or whenever external electrical and hydraulic power is applied to the aircraft. Manual opening of the canopy is conducted using a hand pump system that pumps the canopy into position when combined hydraulic system power is not available on the aircraft. The hand pump is in the nosewheel well and can be operated either from there or from the cockpit.

When the selector valve closes, hydraulic pressure from either the combined hydraulic system or the hand pump system flows through the selector valve into the canopy close line. Pressure in this line is delivered through a flow regulator to the rod end of the canopy actuating cylinder, causing the piston and rod to retract and close the canopy. Opening of the canopy is the reverse of the closing operation.

NOTE: Maintenance of the hydraulic portion of the A-6 canopy actuation system is the responsibility of the AMH rating.

EMERGENCY CANOPY JETTISON SYSTEM

The A-6 canopy jettisoning system is not actuated as part of the seat ejection sequence, but must be manually selected separately from the ejection process. Canopy jettison is a separate function because the normal procedures for using the ejection seat require ejection through the canopy unless special conditions dictate a deviation is necessary. In the A-6, a jettison sleeve is housed in the canopy actuator rod. Passages within the canopy actuator connect to a jettison cartridge that is mounted on the side of the cylinder head end. When the cartridge is fired, expanding gases create the necessary pressure to unlock the jettison sleeve from the rod end and force it and the canopy aft and off the aircraft (fig. 2-7). The jettison cartridge is fired by pneumatic pressure from a small (14.6 cu in.) air bottle pressured with nitrogen to 2,450 psi at 70°F prior to takeoff.

Three air release valves are installed in the aircraft for jettisoning the canopy. One valve is actuated from the cockpit, the other two by their respective RESCUE handle on the engine intake air ducts. Opening any one of these valves directs nitrogen pressure from the bottle to the canopy actuator cap assembly (fig. 2-7) and fires the pneumatic jettison cartridge.

To manually release the canopy actuator from the canopy attachment, pull either of the manual release handles located under access doors on the aft end of the canopy shell or the single manual release handle located on the canopy overhead center beam.

SYSTEM COMPONENTS

The main components of the canopy jettison system are shown in figure 2-6. The relief valve prevents excessive air bottle pressure increases due to thermal expansion and overpressurization during charging. The valve cracks to relieve pressure at 3,800 psi and reseats at 3,400 psi.

The air gauge provides a means of checking proper system precharge. The gauge is tapped into the pressure line between the air bottle and the cockpit air release valve.

The vent bleeder check valve is located on the forward side of the left boarding ladder well. The valve is located downstream of the three air release valves and vents any low-pressure nitrogen that may have leaked past the air release valves, thus preventing inadvertent cartridge actuation. The vent bleeder check valve is normally open at 40 to 80 psi. When an air release valve is actuated, the bleeder valve closes and remains closed throughout the jettison operation. The bleeder valve will reopen when the pressure in the system is reduced below 40 psi. The bleeder valve also has a manual override that permits bleedoff of nitrogen pressure after jettison system testing as required during periodic inspections.

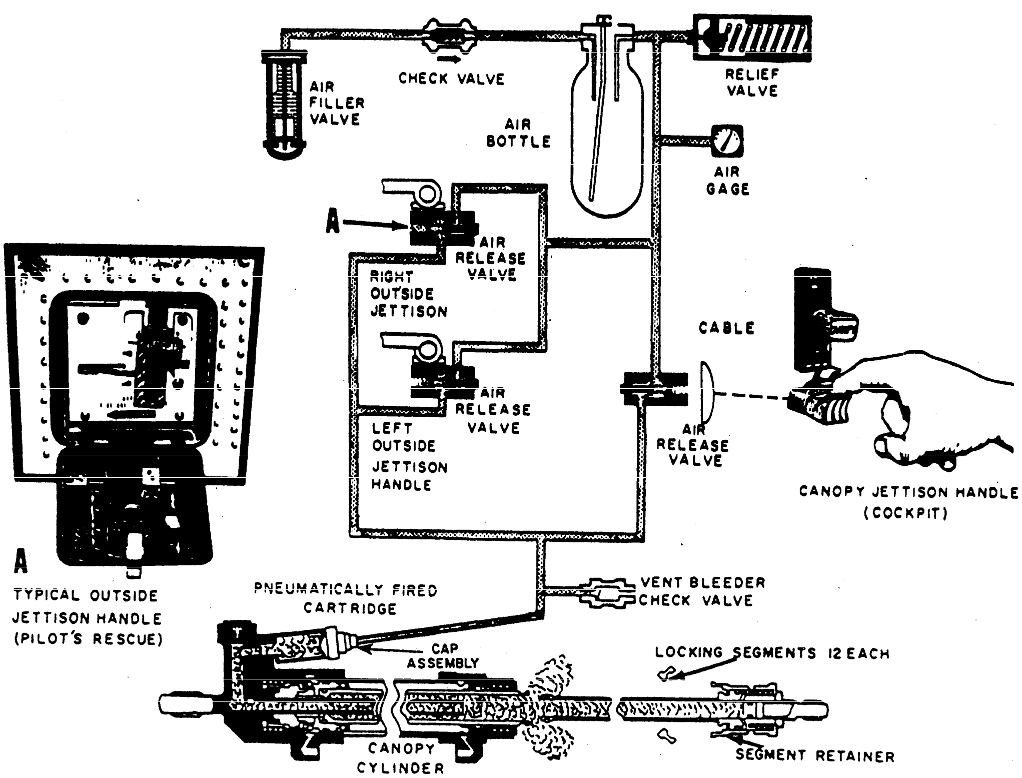

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Figure 2-7.—Canopy jettison schematic.

NOTE: The canopy actuating and jettisoning cylinder is a primary concern of personnel in the AMH rating. However, during AME removal and/or installation of the canopy, the cylinder can become damaged if the procedures provided in the MIM are not strictly followed.

CANOPY SEAL SYSTEM

Learning Objective: Recognize the purpose and operation of the canopy seal system.

A canopy seal system (fig. 2-8) provides an airtight seal between the canopy assembly and the

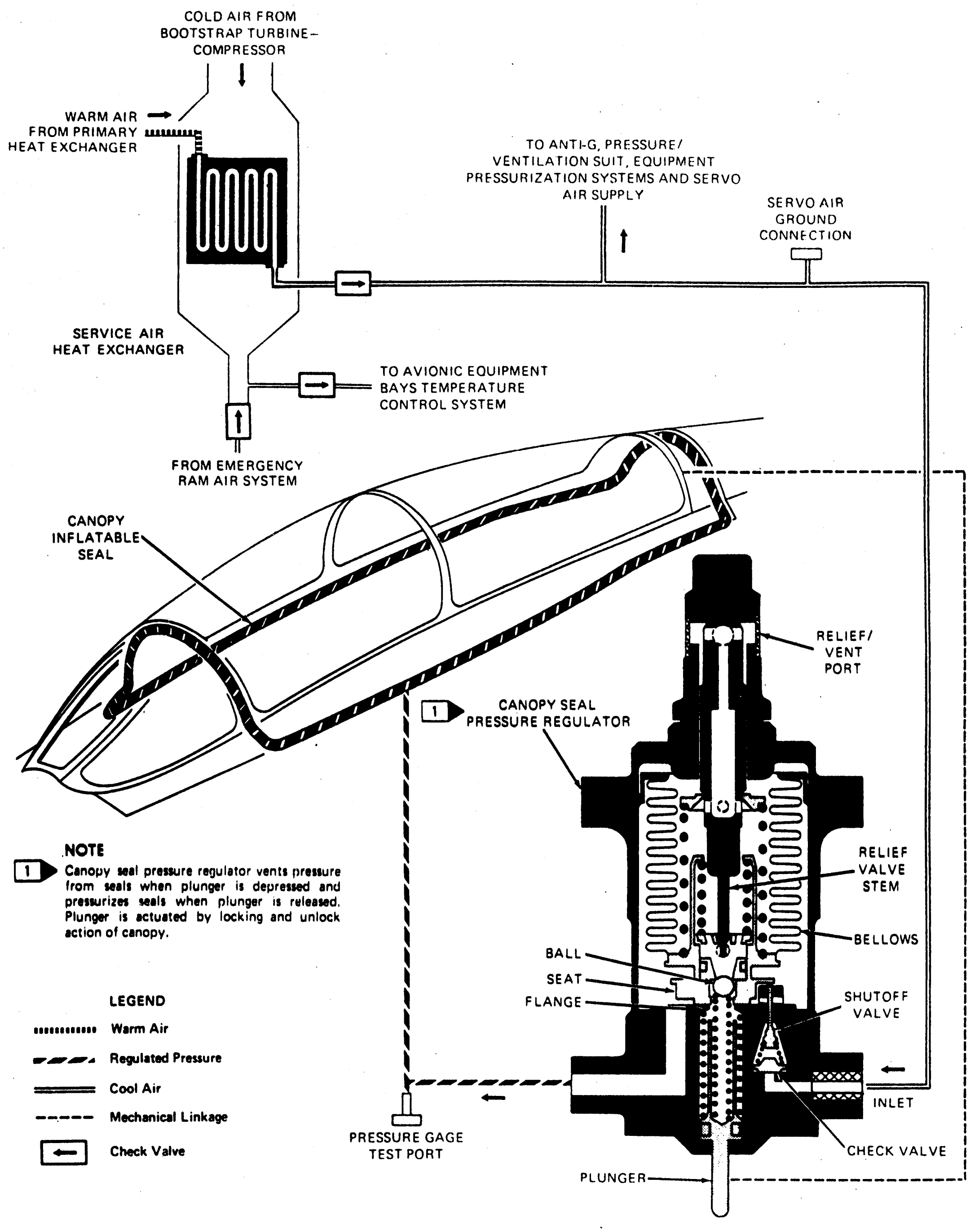

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Figure 2-8.—Canopy seal system.

aircraft structure to maintain cockpit pressurization. The system, using cooled engine bleed air from the air-conditioning system, inflates the canopy seal in response to movement of the canopy locking linkage. The system deflates the seal when the canopy is unlocked. There are many different types/designs of pressure-maintaining seals used on naval aircraft. The main difference between canopy seal systems is the type of canopy seal pressure regulator used, electrical or mechanical. The F-14 inflatable seal will be discussed in the following paragraphs. The A-6 operates in a similar manner, but will not be covered in detail here. Refer to maintenance manuals for specifics.

SYSTEM OPERATION

The canopy seal pressure regulator receives cooled engine bleed air, at approximately 80 psi, from the service air heat exchanger. When the canopy is closed and locked, the regulator plunger is released; this opens the shutoff valve. Air from the regulator inlet then flows past the check valve and shutoff valve, through the outlet port, and to the canopy inflatable seal. As air pressure in the seal increases, pressure buildup in the regulator chamber moves the bellows seat away from the flange. The interior of the bellows is vented to ambient. When pressure in the seal reaches 25±5 psi above ambient, the bellows will

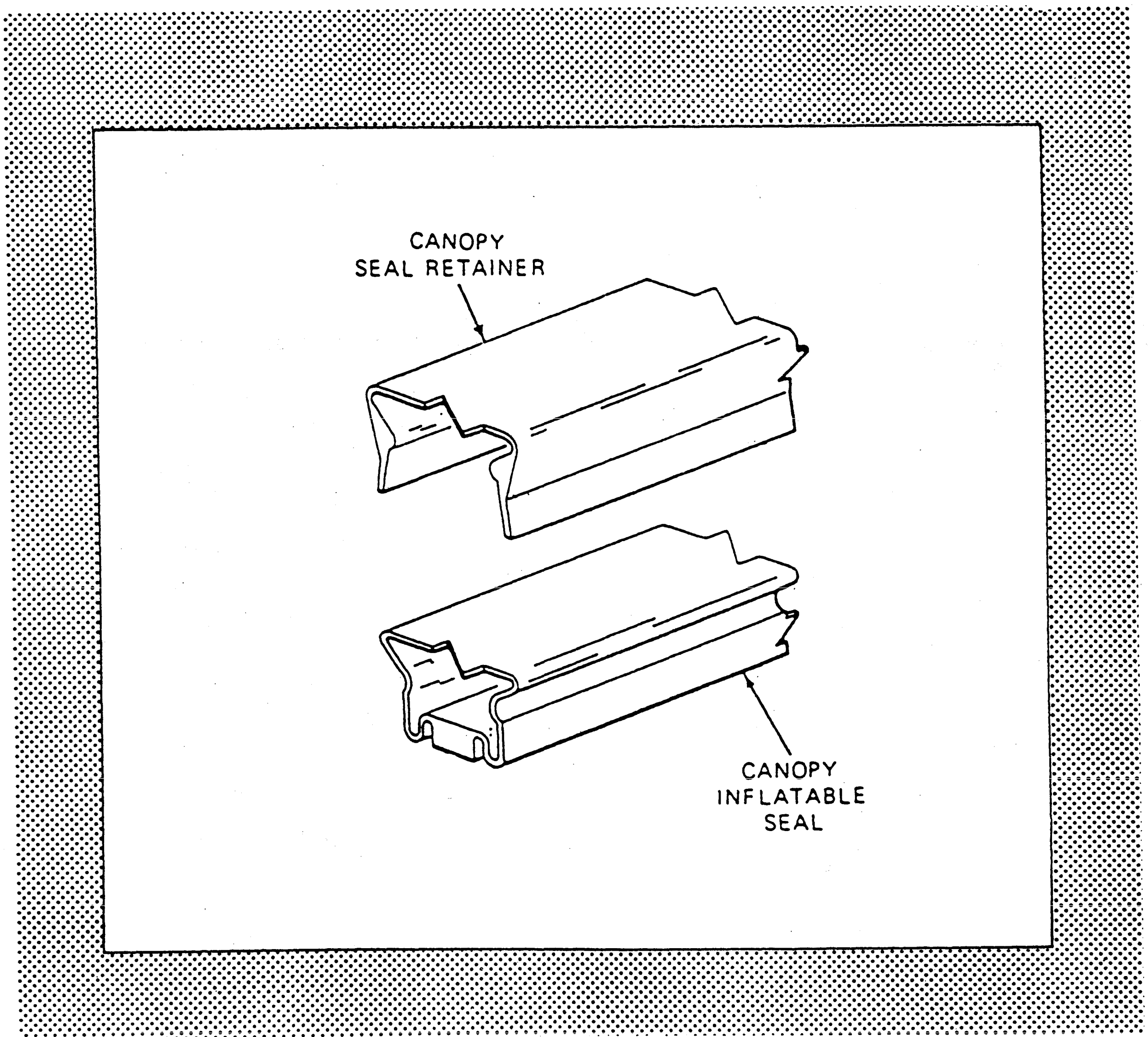

Figure 2-9.—Typical canopy inflatable seal (removed).

have moved sufficiently to seat the shutoff valve and stop flow through the regulator. The inflated seal then fills the gap between the canopy frame and the mating aircraft structure, preventing loss of cockpit pressure. If pressure downstream of the regulator increases to 6 to 8 psi above the regulated pressure, additional bellows movement causes the relief valve stem to unseat the ball in the seat to vent the excess pressure through the relief/vent port. The check valve prevents loss of pressure from the inflatable seal should the air supply to the system fail. When the canopy is unlocked, the regulator plunger is depressed. The plunger moves the bellows seat toward the relief valve stem to close the shutoff valve and unseat the ball, venting downsteam pressure through the relief/vent port. The components of the canopy seal system are discussed in the following paragraphs.

Canopy Inflatable Seal

The hoselike rubberized canopy inflatable seal (fig. 2-9) is retained in a channel around the circumference of the canopy assembly frame. When inflated, the seal fills the gap between the frame and aircraft structure.

Canopy Seal Pressure Regulator

The canopy seal pressure regulator is on the turtle deck (fig. 2-10). It consists mainly of a check valve, shutoff valve, bellows, spring-loaded ball, and plunger. The regulator regulates its 80 psi bleed air input to the 25±5 psi required by the canopy seal system, and controls inflation and deflation of the canopy inflatable seal. The regulator also relieves pressure in excess of 6 to 8 psi above the regulated value.

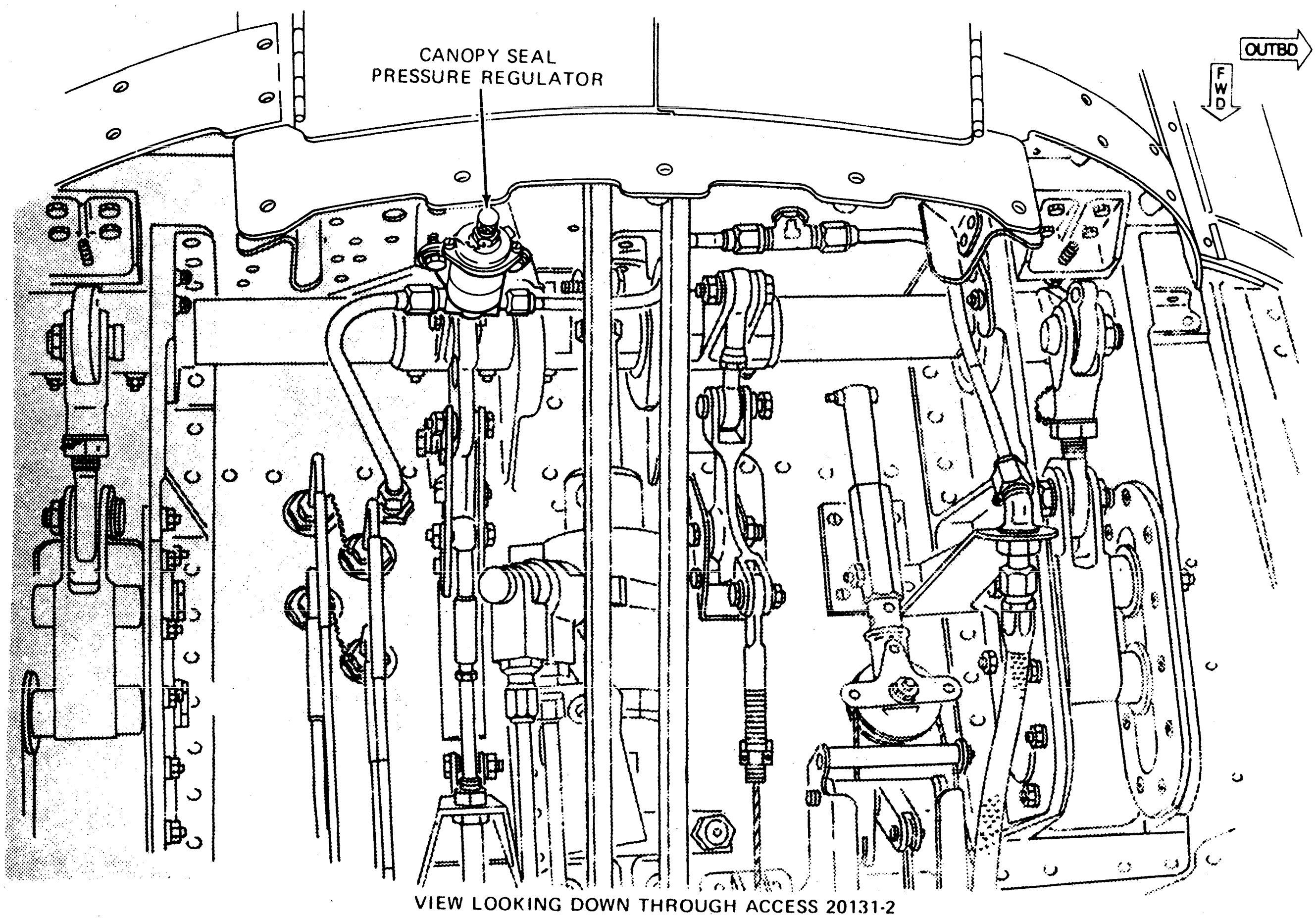

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Figure 2-10.—Canopy seal pressure regulator location.

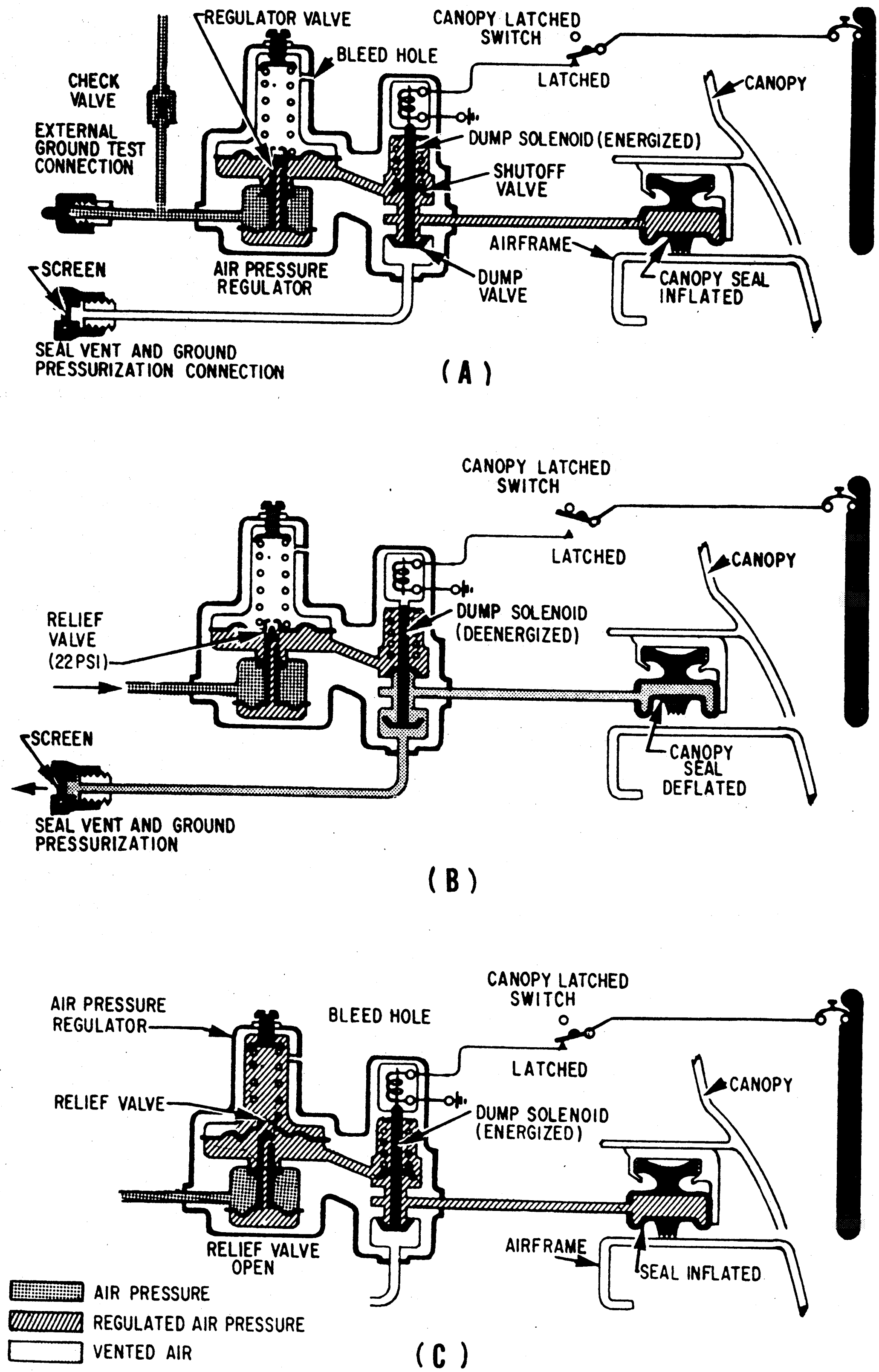

Figure 2-11.—Electrically actuated canopy pressure seal system.

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Electrically Actuated Canopy Seal

An electrically actuated canopy pressure seal system is shown in figure 2-11. This type of system is controlled by a pressure regulator and dump valve assembly, which consists of a pressure regulator, a solenoid poppet shutoff and vent valve, and a relief valve.

Electrically Actuated Canopy Pressure Seal Regulator Valve

The canopy pressure seal regulator valve controls the pressurizing and depressurizing of the canopy seal, depending upon the canopy position. The pressure regulator consists of a spring-loaded diaphragm, which controls a poppet valve to admit the correct air pressure to the canopy seal. An adjustment screw is provided at the top of the regulator housing to adjust the output of air pressure.

The shutoff and dump valve consists of a solenoid-operated poppet valve, which is spring-loaded to the closed position. When the solenoid is energized (fig. 2-11, view A), the dump valve closes the vent port and opens the regulator shutoff to permit inflation of the canopy seal. The outlet pressure is maintained at approximately 20 psi by the pressure regulator.

When the solenoid is de-energized by the opening of the canopy (fig. 2-11, view B), the dump valve opens the vent port, closes the regulator shutoff to stop the flow of supply air, and dumps the pressure in the canopy seal overboard through the vent line. The relief valve feature of the pressure regulator prevents seal pressure from becoming excessive during rapid altitude changes by venting the seal pressure overboard when the pressure reaches a maximum of 22 psi (fig. 2-11, view C).

In case of an electrical failure, the regulator valve is spring-loaded in the dump position.

Ground Test Connections

Most canopy pressure seal systems have ground test connections that are used to ground test the system and to pressurize the system during carrier deck storage. The ground test connections (fig. 2-12) are usually located on the cabin air pressure test panel. One connection is used for ground test, and the other, which is normally the seal vent, is used for ground pressurization of the canopy seal.

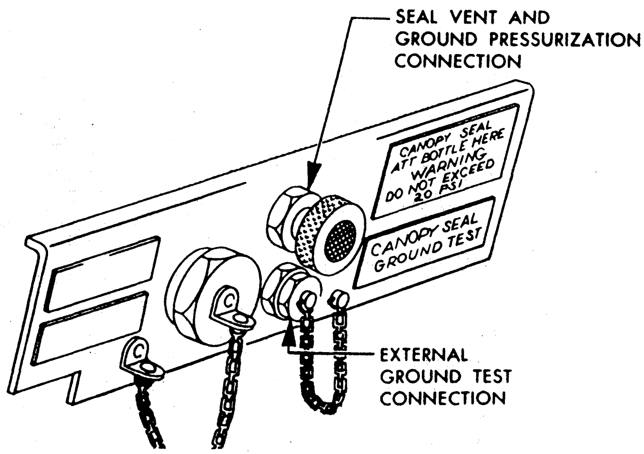

Figure 2-12.—Cabin air pressure test panel.

MAINTENANCE

Maintenance of the canopy system consists of servicing, troubleshooting, and removal and installation of components. The applicable aircraft maintenance instructions manual (MIM) furnishes such information as proper procedure, manpower requirements, materials lists, tool and equipment lists, quality assurance instructions, and maintenance-level instructions for the disposition of defective parts.

Servicing

Servicing is limited to cleaning the canopy seal, ground inflating the canopy seal, and periodic inspections for visible defects, dirt, and foreign material accumulations. All major components of the system are self-sustaining and require no general servicing between overhaul periods for normal operation.

When pressurized aircraft are stowed on the carrier flight deck without canopy covers, the canopy seal should be inflated externally to protect the cabin area. Ground pressurization of the canopy seal is accomplished by attaching an external air source to the canopy seal vent and ground pressurization connection (fig. 2-13). Since air pressure applied to this fitting bypasses the system regulator, the air source must be controlled to less than 20 psi to avoid rupturing the seal.

NOTE: Some aircraft are equipped with canopy rain seals that protect the cabin area. In aircraft so equipped, the canopy seal does NOT have to be inflated for the cabin to be protected. Rain seals do not maintain cockpit pressurization.

Troubleshooting

Troubleshooting charts similar to the one in table 2-1 are found in most aircraft MIMs. The troubleshooting chart is provided as an aid in determining the cause, isolation procedure, and remedy for the more common malfunctions within the canopy seal system. When a malfunction is suspected, always ensure that the proper controls have been activated to provide operating potential to the unit to be inspected.

Removal and Installation Procedures

The MIM provides the instructions and visual aids necessary to remove and install the various components of the canopy seal system. In addition to instructions, information such as disposition of defective parts, tools and equipment requirements, and quality assurance instructions is provided. When removing a unit from the aircraft, always ensure that proper measures are taken to prevent the entry of dirt and foreign material into ports and ducts that have been opened to accommodate removal.

FRANGIBLE ESCAPE CANOPY SYSTEMS

Learning Objective: Recognize the purpose and operation of a frangible escape system.

A frangible escape system is an explosively operated system that cuts an exit through the canopy directly over the head of each occupant. The S-3A canopy removal system is an example of this type system, and it employs shielded mild detonating cord (SMDC) in lieu of hot gas and flexible linear shaped charge (FLSC) in lieu of actuators found in other hot gas explosive systems.

Normal entry and exit of the S-3A aircraft is through an entrance hatch vice a canopy, as in other ejection seat type of aircraft. Therefore, the S-3A canopy removal system is used primarily for emergency ground egress and water rescue. Normal seat ejection is through the canopy glass for the front seats and through the hatch glass for the rear seats. In both cases, exit is made without benefit of having the glass removed or cut because the seats are equipped with glass crashers. Breaker plates are installed on each canopy and hatch to assist the seat during ejection. A brief description of the frangible escape canopy system components is provided in the following paragraphs.

EXTERNAL CANOPY AND HATCH JETTISON INITIATOR

Two external jettison initiators are installed inside access doors, one on each side of the aircraft just below and forward of each windshield

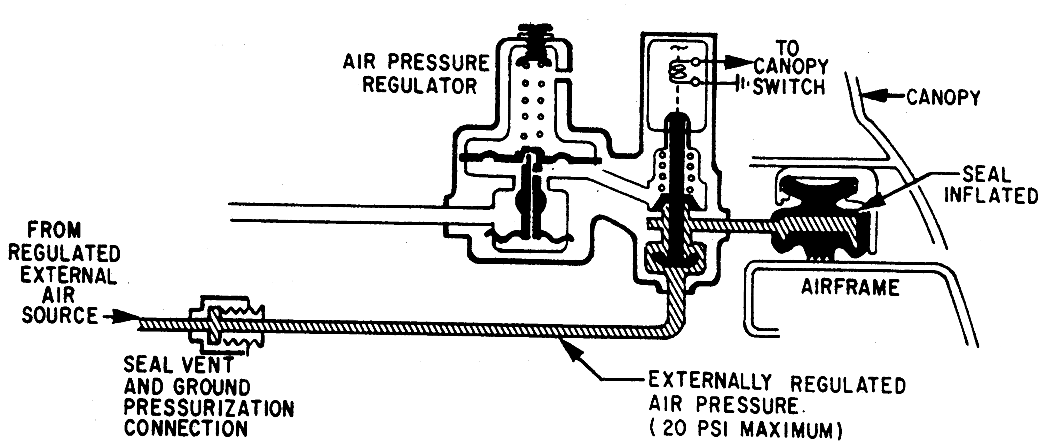

Figure 2-13.—Ground inflation of the canopy seal system.

Table 2-1.—Troubleshooting Chart For Electrically Actuated Canopy Seal System

Probable cause	Isolation procedure	Remedy
TROUBLE: SEAL WILL NOT INFLATE DURING NORMAL OPERATIONS		
Ruptured seal.	Check the canopy seal by applying an internal air pressure source to the ground test fitting and operating the canopy seal system.	Replace defective seal.
Improperly adjusted or defective canopy latched switch.	Check the adjustment of the canopy latched switch or continuity.	Properly adjust canopy latched switch or replace defective switch.
Defective canopy seal regulator power supply circuit.	Check continuity.	Personnel in the AE rating will repair or replace electrical wire or components as necessary.
Defective canopy seal regulator.	Check continuity.	Replace defective canopy seal regulator.
Canopy seal ground test fitting cap loose or missing.	Check visually.	Tighten or replace the cap.
Canopy seal ground test fitting cap and canopy seal vent fitting reversed.	Check visually.	Reverse fittings.
TROUBLE: SEAL WILL NOT INFLATE DURING GROUND TESTING		
Check valve defective.	Ground test the canopy seal system.	Replace check valve O-rings or replace check valve.
Defective canopy seal regulator.	Check continuity of electrical solenoid. Check canopy seal.	Replace canopy seal regulator.
Ruptured seal.	Check canopy seal.	Replace defective seal.
Defective canopy seal regulator power supply circuit.	Check continuity.	Personnel in the AE rating will repair or replace electrical wire or components as necessary.

(fig. 2-14). The initiator consists of a mechanically actuated sealed explosive device containing a handle, four locking balls, a 10-foot wire lanyard, a mechanical firing mechanism, a transfer booster assembly, body shield, and a ball lock mechanism. The 10-foot wire lanyard attaches the handle to a mechanical firing mechanism. The firing mechanism consists of a sear pin, cap, spring, and firing pin enclosed in the body of the initiator. The transfer booster assembly contains a percussion primer, an initiation explosive charge, and an output explosive charge. The transfer booster assembly produces a detonation wave that initiates the SMDC assembly, which is screwed into the initiator's outlet port.

When the initiator handle is pulled, the locking balls will retract and release the handle from the shield. The handle and attached lanyard are pulled the length of the lanyard (10 feet) from the initiator. With the wire lanyard extended to its full length, an additional 0.75-inch movement of the handle will allow the firing pin to separate from the sear pin. The firing pin, which is now disengaged and under spring tension, strikes the percussion primer, which is installed in the transfer booster assembly. The primer ignites the initiation and output explosive charges, producing a detonation. The detonation wave initiates the SMDC assembly, which is installed in the outlet port of the initiator.

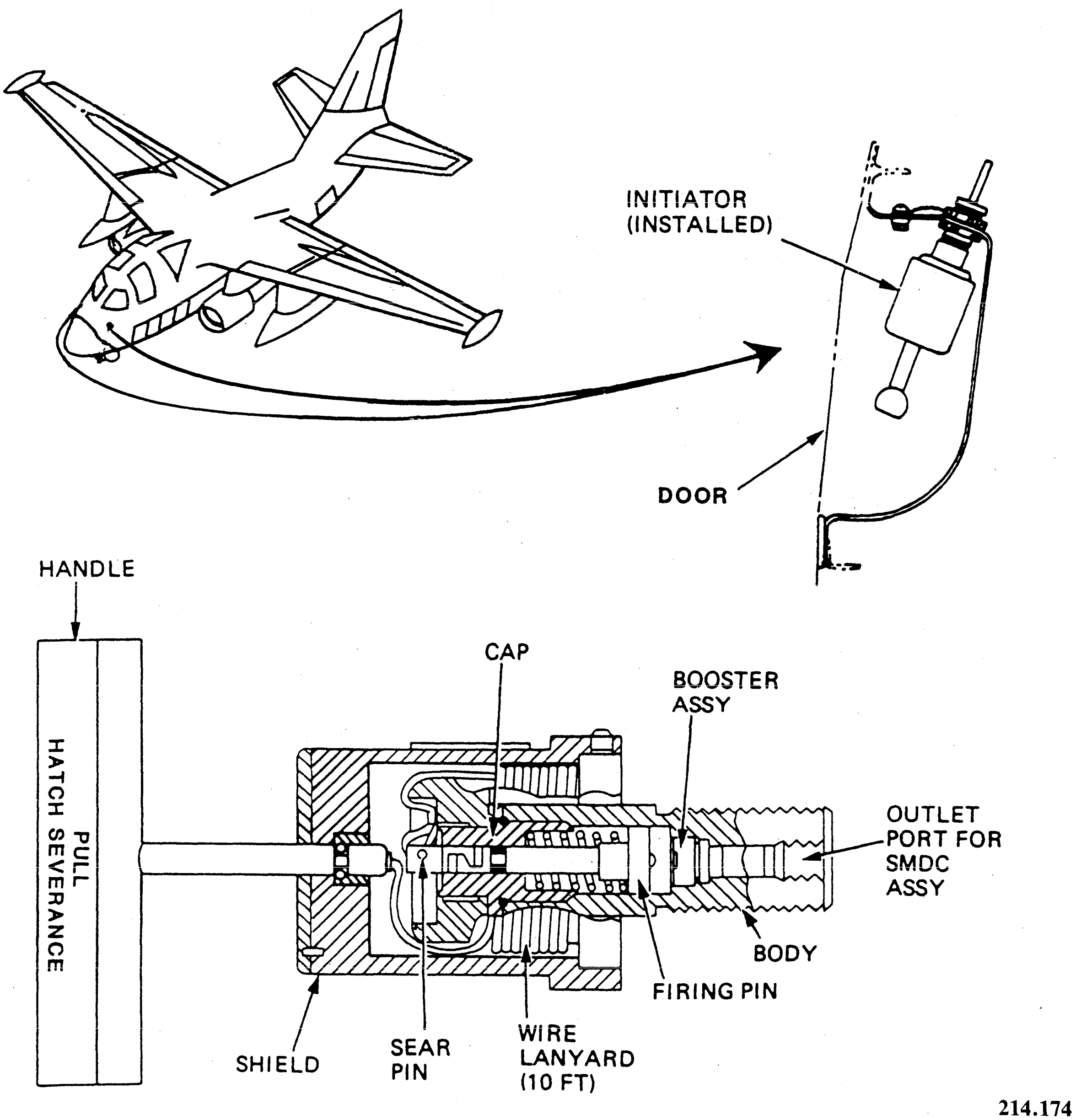

Figure 2-14.—External canopy and hatch jettison initiator.

The external initiators have no safety pins as such, but rely upon the 10-foot lanyard to protect them against inadvertent initiation. Operation of either external handle will cause all four hatches, fillets, and supports to be blown away from the aircraft. Partial withdrawal of any handle is cause for rejection and replacement.

INTERNAL CANOPY AND HATCH JETTISON INITIATOR

The internal initiator is used to actuate the canopy and hatch system without activating the ejection seat system. Three internal initiators are located in the S-3A aircraft crew compartment. One initiator is located in the overhead between the pilot and copilot. The other two are located at the TACCO and SENSO positions on the outboard side of each instrument panel (fig. 2-15).

The initiator is a mechanically actuated sealed-in device containing a squeeze-to-pull type of handle (fig. 2-1 5), a mechanical firing mechanism, and a transfer booster assembly. The mechanical firing mechanism and transfer booster assembly are identical to those used in the external system.

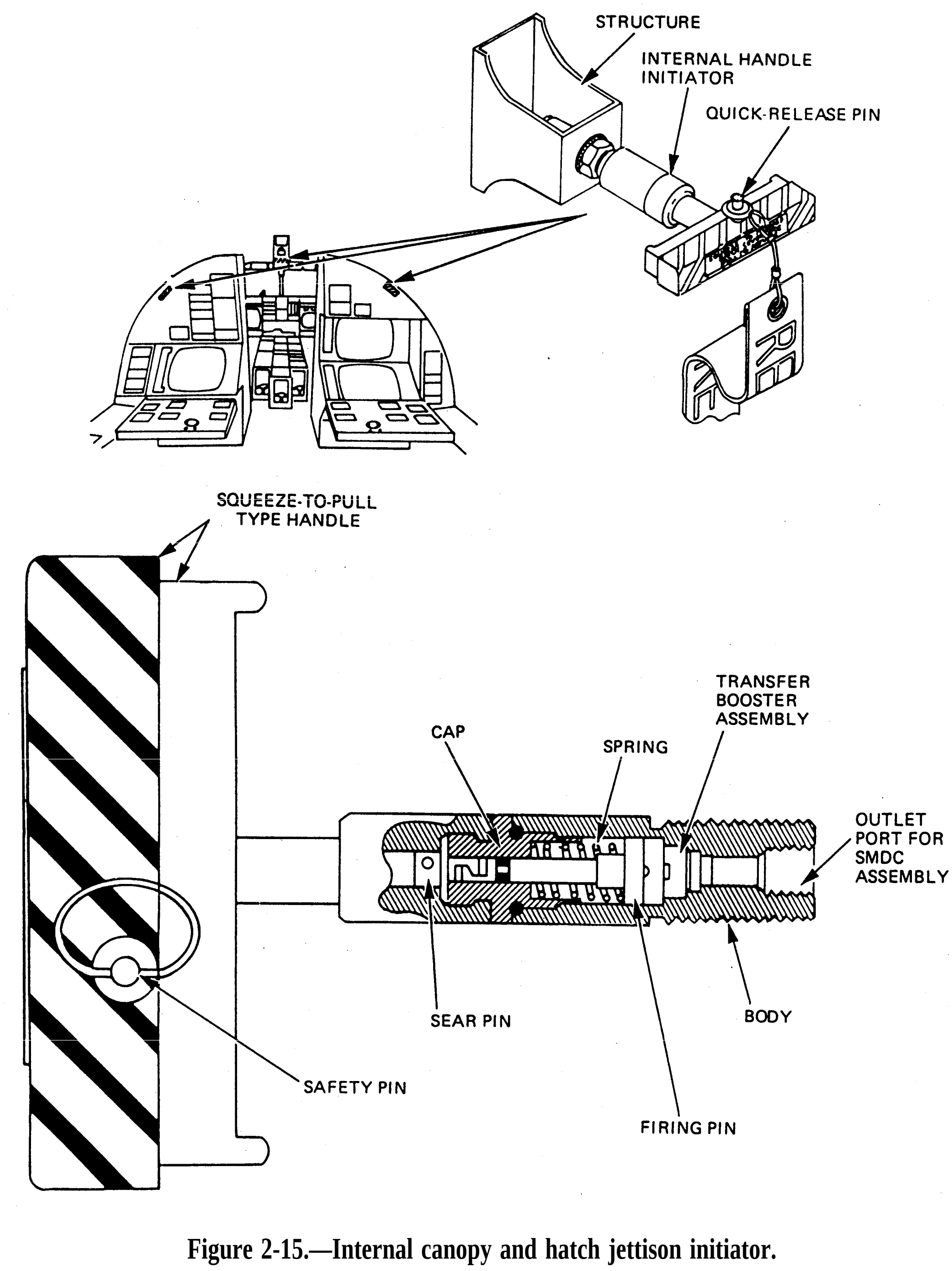

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Figure 2-15.—Internal canopy and hatch jettison initiator.

The firing mechanism is secured in the safe position by a safety pin that passes through the handle. The safety pin prevents the handle from being squeezed and pulled.

When the initiator handle is squeezed and pulled for a distance of 0.75 inch, the firing pin separates from the sear pin. From this point, the sequence is identical to the external canopy and hatch jettison sequence.

SHIELDED MILD AND FLEXIBLE CONFINED DETONATING CORDS

The SMDC and FCDC segments act as the plumbing for the emergency egress system. They provide all internal and external jettison initiators with manifolds and one-way transfers to all explosive charges. Some S-3A aircraft have been modified to incorporate FCDC in place of the SMDC at the four locations where the canopies and/or hatches meet the airframe. The use of the FCDC alleviates the installation problems encountered with SMDC. The SMDC and FCDC focus extremely high velocity and pressures onto the ends of adjacent SMDC segments.

The high reaction speed of 8,000 to 9,000 feet per second makes the SMDC very difficult to unintentionally detonate from extraneous sources such as sawing, filing, drilling, and hammering because the speed of these operations does not approach the 8,000 to 9,000 feet per second requirement. From the standpoint of manufacturing and maintenance personnel, the system is virtually inert when safety pins are installed.

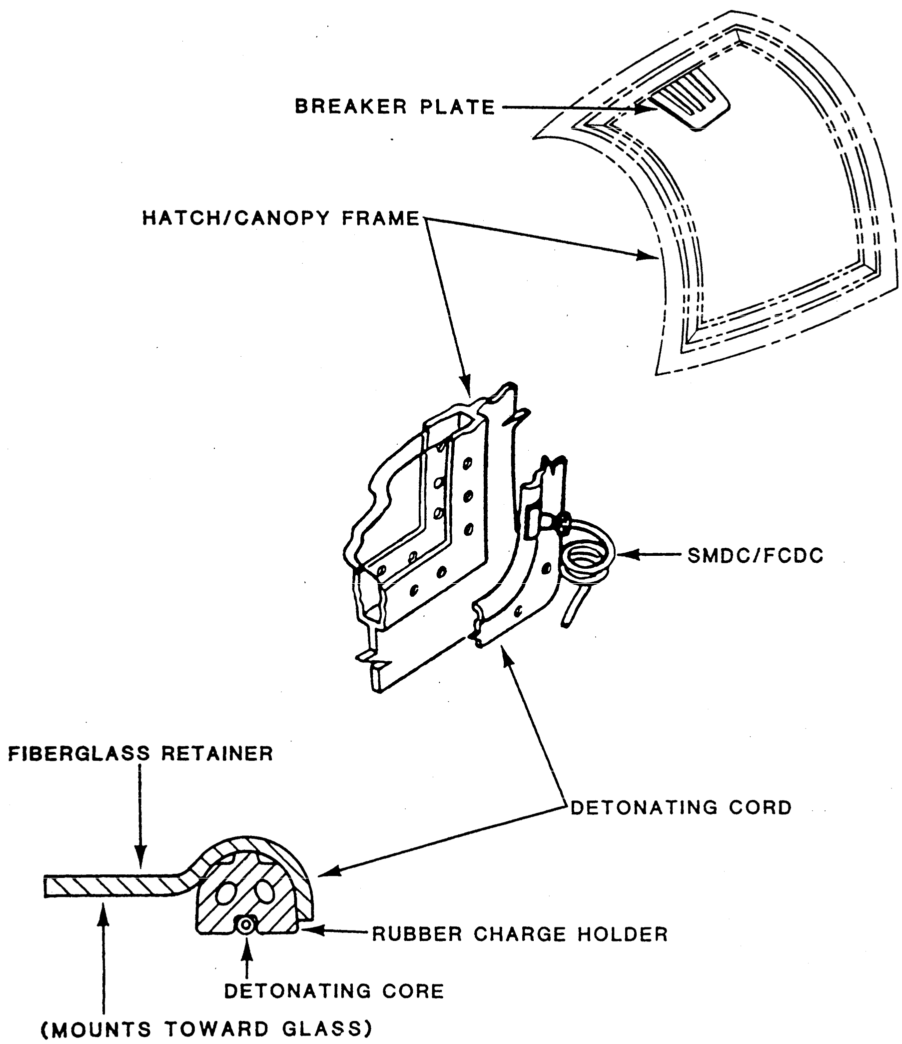

Figure 2-16.—Hatch/canopy detonating cord assembly.

The ends of the SMDC, while in storage or not connected in the aircraft, must be capped at all times. Any scaring or deformation of the transfer tip is cause for rejection. Any deformity here will affect the direction the blast force will travel. The tips of the SMDC act as both donor and acceptor to receive and transfer the charge from one SMDC segment to another. The tips contain Hexanitrostilbene II (HSN II) while the cord charge itself is Hexanitrostilbene I, a less sensitive material.

CANOPY AND HATCH EXPLOSIVE CHARGE

An explosive charge is attached to the periphery of the pilot and copilot canopies and the TACCO and SENSO hatches. The explosive charge is a detonating cord, and it is applied directly to the glass on the canopies and/or hatches. Each detonating cord assembly is held in place by a silicone rubber charge holder and fiber glass retainer (fig. 2-16). The detonating cord consists of a continuous explosive charge contained in an O-shaped seamless lead sheath. A threaded inlet port (transfer block) is mounted on the fiber glass retainer to allow attachment of the SMDC or FCDC assembly. An SMDC or FCDC connects to the transfer block at the lower front corner of each charge.

Actuation of an external or internal canopy and hatch jettison initiator detonates the SMDC or FCDC screwed into the inlet port of the detonating cord assembly. The detonation wave impacts and initiates the explosive booster charge, which, in turn, initiates the detonating cord. Initiation of the detonating cord fractures the stretched-acrylic canopy or hatch along its periphery. The first half of the glass is vaporized by the heat of the flame, which slices a very narrow and deep incision halfway through it. At this point, the shock wave is sufficient to fracture the remaining thickness and spatter the glass outward.

FILLET SEVERANCE EXPLOSIVE SHAPED CHARGE

During emergency ground egress, FLSC assemblies sever the S-3A aircraft's left and right upper wing-to-fuselage fillet supports. The FLSC cuts the attached fillet from the aircraft to allow complete egress through the respective hatch.

The FLSC assembly is enclosed in a silicone rubber charge holder, which is held in place by a fiber glass retainer (fig. 2-17). The FLSC is a continuous explosive charge contained in a V-shaped seamless lead sheath. The silicone rubber shaped charge holder is extremely vulnerable to external damage because of the softness of the material and 0.02-inch material thickness in the area of the FLSC. A cut or tear of the charge holder, which allows the lead sheathed shaped charge to become exposed, destroys the environmental seal and requires replacement of the FLSC assembly.

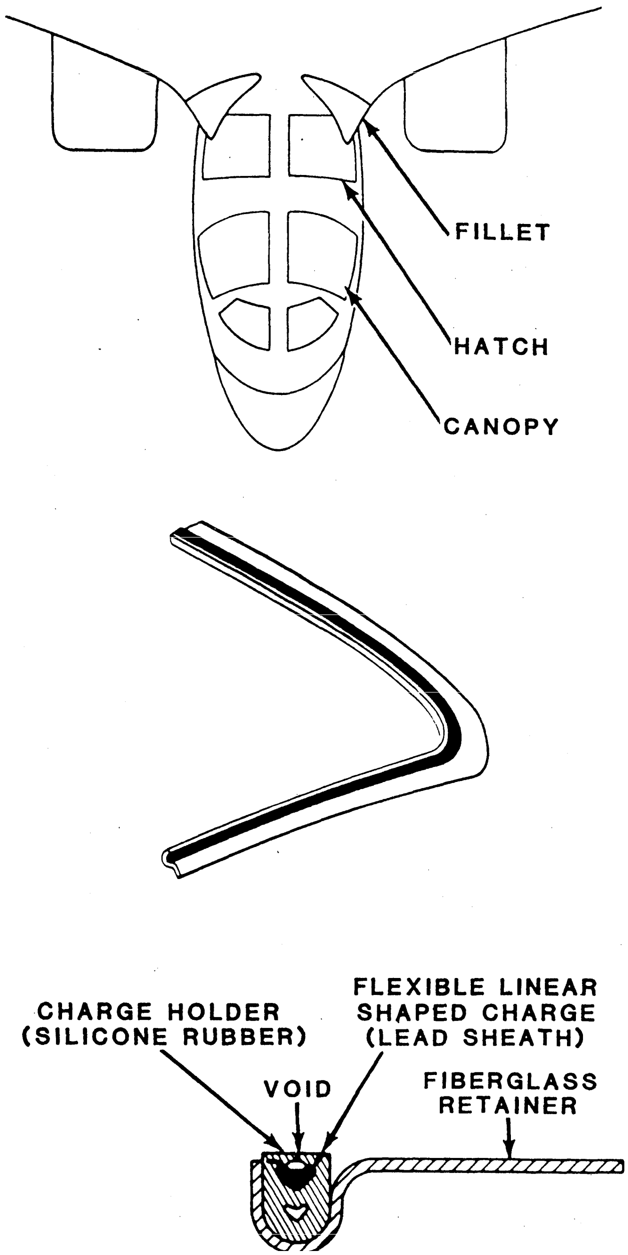

Figure 2-17.—Fillet FLSC assembly.

SMDC ONE-WAY TRANSFER

Two SMDC one-way transfers are located on the pilot and copilot bulkhead. The SMDC one-way transfer acts as a check valve or one-way detonating transfer device. The SMDC one-way transfer is a self-contained unit that houses a sealed receptacle for dual-shaped charges. Any detonation entering the inlet ports will transfer to the outlet port. Any detonation originating from the aft port (TACCO or SENSO) segment of the SMDC one-way transfer will not transfer forward. This would occur when either the TACCO or SENSO elects to cut their respective hatch. The remaining two windows and the opposite hatch would not be affected.

SYSTEM OPERATION

The S-3A aircraft canopy and hatch severence system contains two external and three internal SMDC initiator handles (fig. 2-18). Actuation of the pilot's or copilot's internal handle or either of the two external handles severs the pilot and copilot canopies, TACCO and SENSO hatches, right and left upper wing-to-fuselage fillets, and the right and left wing fillet supports.

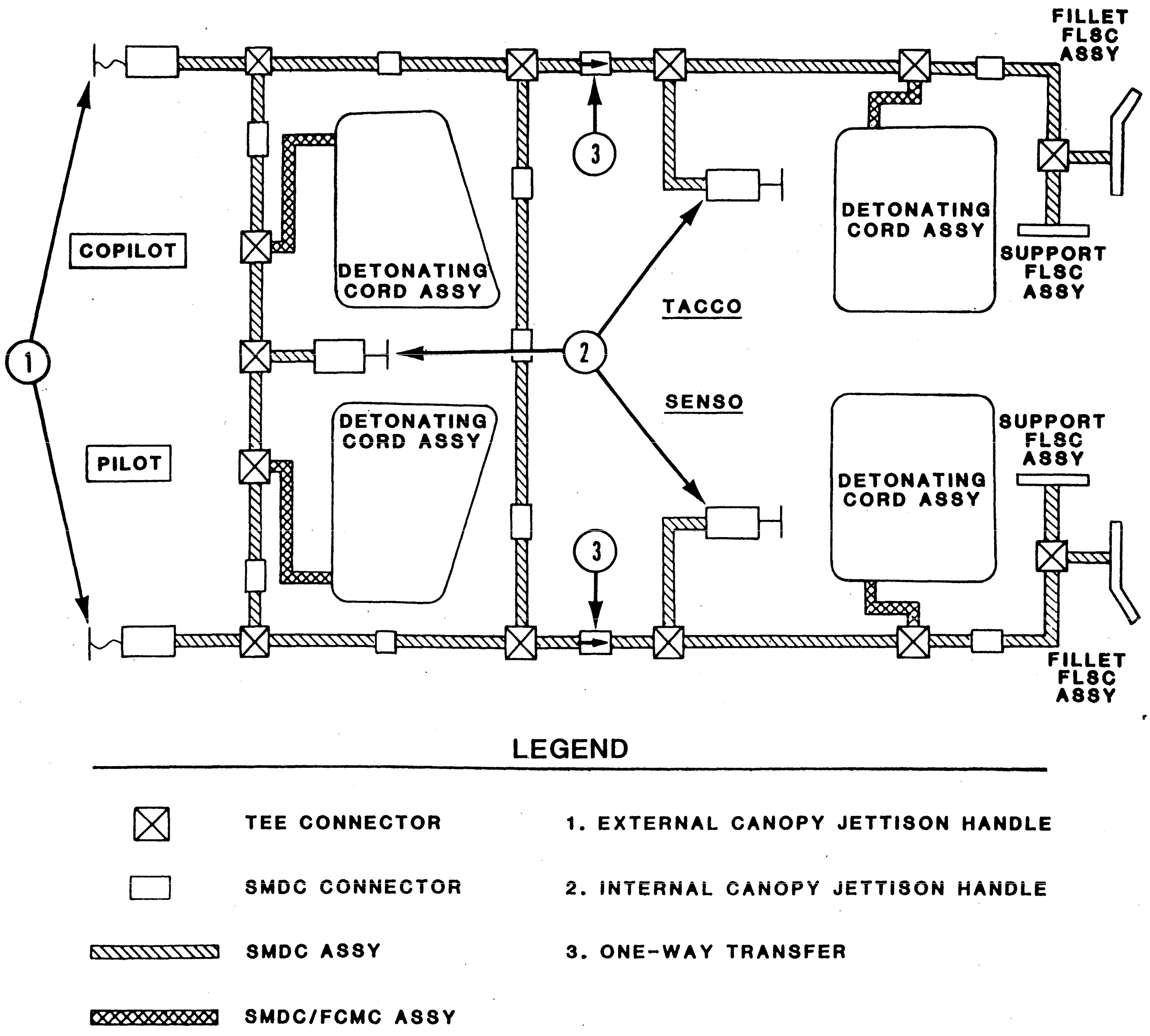

Figure 2-18.—Emergency egress schematic.

The pilot's and copilot's internal initiator handles transfer a detonation wave signal to the connecting SMDC assemblies, which are routed throughout the cockpit area. In turn, the SMDC assemblies initiate four detonating cord assemblies, which are mounted on the periphery of the two canopies and the two hatches. The detonating cord assemblies sever or fracture the stretched acrylic canopies and hatches. FLSC assemblies, which are simultaneously initiated, sever the two wing fillet supports and the two upper wing-to-fuselage fillets, which extend into the TACCO and SENSO hatch area.

Actuation of the TACCO or SENSO internal SMDC initiator will sever only the hatch, the upper wing-to-fuselage -fillet, and the wing fillet support at the crew station in which the initiator was activated. Explosive one-way transfers located forward of the TACCO and SENSO crew stations prevent the detonation wave from severing the pilot and copilot canopies.

It is virtually impossible to initiate the system at any point other than an initiator handle. As compared to hot-gas systems, this system maybe considered immune to ordinary shop hazards. The system is self-sufficient and independent. It depends upon no other system for aid or assistance, and it does not contribute aid, assistance, or sequence to any other aircraft system. The S-3A system is much less susceptible to inadvertent actuation than hot-gas systems, and hence more convenient and safe for maintenance personnel.

CARTRIDGES AND CARTRIDGE-ACTUATED DEVICES (CAD)

Learning Objective: Recognize the service life and expiration dates of cartridges and cartridge-activated devices.

The types of explosive devices incorporated in egress systems are varied. The AME working with these devices must know how they function, their characteristics, how to identify them, their service-life limitations, and all safety precautions.

The AME who understands the importance of all of these factors and who correctly uses the maintenance manuals is better equipped to supervise and train others. The following manuals are required for the AME to meet the above requirements:

1. *Description, Preparation for Use, and Handling Instructions, Aircrew Escape Propulsion System (AEPS) Devices,* NAVAIR 11-85-1
2. *General Use Cartridges and Cartridge Actuated Devices for Aircraft and Associated Equipment (CADS),* NAVAIR 11-100-1.1, NAVAIR 11-100-1.2, and NAVAIR 11-100-1.3
3. Specific aircraft MIMs
4. OP 4, *Ammunition Afloat*
5. OP 5, *Ammunition and Explosives Ashore*

SERVICE LIFE

The service life of a CAD is the specific period of time that it is allowed to be used. These periods of time are affected by various environmental conditions, which have resulted in the assignment of time limits or overage requirements. These limits are shelf life and installed life.

The establishment of service-life limits is based upon design verification tests, qualification tests, and surveillance evaluations. The established limits are approved by the Naval Air Systems Command. Therefore, the establishment of service-life time limits is not arbitrary and must be adhered to as specified.

Prior to deployment to areas that do not permit ready supply and servicing of cartridges or cartridge-actuated devices, an inspection must be made of all CAD's service-life expiration dates. If, during this inspection, it is determined that a CAD will become overage during the period of the deployment, the CAD must be replaced prior to the deployment. Before installation of any CAD, the service-life expiration date of the unit must be checked to ensure that the unit is not overage and will not become overage prior to the next periodic maintenance cycle of the aircraft.

During standard depot level maintenance (SDLM), the expiration dates of all installed CADs must be checked. Those CADs assigned to organizational level for maintenance and that have expiration dates prior to the next scheduled inspection after the aircraft is returned to its custodian must be replaced. CADs assigned to depot level for maintenance that have expiration dates falling prior to the next scheduled SDLM should also be replaced. The exception is systems replaced exclusively through the use of a field modification team. Adherence to these procedures will prevent loss of aircraft mission capability due to CAD service-life expiration.

EXPIRATION DATES

To determine service-life expiration dates, both the shelf life and installed life must be computed. First, compute the shelf life of the CAD by using its lot number to determine the month and year of manufacture. Refer to table 2-2 to ensure correct interpretation of the lot number since there are currently two methods used to derive lot numbers. Obtain the established shelf life (number of months and years) for the individual CAD from the NAVAIR 11-100-1 series manual. Add this figure (shelf life) to the month and year of manufacture determined from the CAD lot number. The resulting sum (date) is the shelf-life expiration date of the CAD in question.

Example:

Lot number/date of manufacture	0579
+ Shelf life in Years	+ 6
Shelf-life expiration date	0585

Table 2-2.—Derivation of Lot Number

KEY	DEFINITION
a	Lot sequence number
b	Manufacturer's identification symbol
c	Month of production (two digit)
d	Year of production (two digit)
e	Month of production (single alpha) JAN - A MAY - E SEP - J FEB - B JUN - F OCT - K MAR - C JUL - G NOV - L APR - D AUG - H DEC - M
f	Interfix number
g	Lot suffix (alpha)

Example:
Lot Number, Method 1: 11 ABC 0578
Key: (a) (b) (c)(d)
(Note that (c) and (d) will be used to compute service life.)

Example:
*Lot Number, Method 2: XYE 78 E 001-011A
Key: (b) (d) (e) (f) (a)(g)
(Note that (d) and (e) will be used to compute service life.)
*Further details of explanation are available in MIL-STD-1168A.

Next, determine the installed-life expiration date of the CAD by referring to the NAVAIR 11-100-1 series manual. Obtain the installed-life figure (number of months or years) and add that figure to the date (month) the CAD's hermetically sealed container was opened. The resulting sum (date) will be the installed-life expiration date for the CAD in question.

Example:

Date opened	0879
+ Installed life in months	+42
Installed-1ife expiration date	0283

Then, compare the two dates derived (shelf life and installed life). Whichever date occurs first is the CAD service-life expiration date.

Example:

Shelf life	0585
Installed Life	0283
Service-life expiration date	0283

Since only the month and year are used in computing service-life dates, the date the hermetically sealed container is opened and the expiration date must be computed to the last day of the month involved. If the date the sealed container was opened is not available, the installed life must be computed from the date of manufacture as determined from the lot number.

MARKING EXPIRATION DATES

Before installing a CAD in an aircraft system, both CAD service-life expiration dates (shelf life and installed life) must be known. The time limit that is exceeded first is the service-life expiration date of the CAD. This date must be entered into the aircraft logbook.

Use permanent indelible ink for marking CADS with container open dates and service-life expiration dates. DO not scribe, scratch, or electroetch these dates, as damage will occur to the CAD's corrosion-resistant surface. The marking pen, NSN 7520-00-043-3408, is available from GSA supply and is recommended for this purpose.

When you install a CAD in an aircraft system, a log entry must be made on OPNAV Form 4790/26A as directed by OPNAVINST 4790.2. When a CAD's hermetically sealed container is opened, the container open date and the service-life expiration date (month and year) must be marked with indelible ink on the container and on each CAD in the container.

SERVICE-LIFE EXTENSION

Contingency service-life extensions for the CADS listed in the NAVAIR 11-100-1, not to exceed 30 days, may be granted by the commanding officer or his authorized representative. These extensions may be applied to a specific CAD on a one-time-only basis when replacements are not available and failure to extend the service life would disrupt flight operations. The contingency authority is granted on the condition that Naval Ordnance Station (NAVORDSTA), Indian Head, Maryland; NAVAIRSYSCOM, Washington, D.C.; and SPCC, Mechanicsburg, Pennsylvania be immediately notified by message or speed letter when such authority is exercised.

When the situation warrants, an additional service-life extension beyond the 30-day contingency extension may be requested by message from the NAVORDSTA. All extensions beyond 30 days must be approved by the NAVORDSTA or NAVAIRSYSCOM. All approved additional service-life extensions will be transmitted by message to the activity making the request. When a service-life extension is granted, an entry must be made in the aircraft logbook. When an aircraft is transferred with a service-life extension in effect, the gaining activity must be notified, and no new contingency service-life extensions may be granted by the commanding officer of the gaining activity.

SERVICE-LIFE CHANGE

The permanent service life of a CAD may be changed only by a rapid action change (RAC), interim rapid action change (IRAC), or formal change to NAVAIR 11-100-1 as directed by Commander, Naval Air Systems Command (COMNAVAIRSYSCOM), Washington, D.C. If the change affects those items installed in an aircraft, the change will be recorded in the aircraft's logbook.

A line will be drawn through the service-life expiration date shown and the new computed expiration date entered citing the authority for the change; for example, message number, rapid action change number, or change number. Each new expiration date will supersede the previous date. The latest expiration date entered in the aircraft logbook will always be the final date the CAD may remain installed in the aircraft.

When a contingency service-life extension has been authorized for a specific CAD, the new computed service-life expiration date (month and year) will be added to the original aircraft logbook entry for that CAD. When an additional service-life extension has been granted for a specific CAD, the new service-life expiration date (month and year) will be added to the original aircraft logbook entry.

CAD MAINTENANCE POLICY

Learning Objective: Identify CAD maintenance policy to include SMDC and FCDC maintenance and inspection requirements and safety precautions.

CAD maintenance policy prohibits unauthorized maintenance or adjustment to a CAD at any of the three levels of maintenance: organizational, intermediate, or depot. Authorized maintenance actions are limited to removal, inspection, and replacement unless specifically detailed in the aircraft MIM or by a technical directive.

CADS and items of equipment in ejection systems are for one-time use only. They are never to be refurbished or used again after firing. This is equally true of functional equipment, rigid lines, plumbing lines, and hoses. Ejection seats and escape system components that have been used in an ejection or fired, regardless of apparent condition, are prohibited from reuse and must be disposed of as directed by OPNAVINST 4790.2, OPNAVINST 3750.6, and the applicable CAD and rocket manual.

Because of the extreme stress and strain to the ejection seats and escape system components during ejection, they cannot be reused. This stress could reduce the structural or mechanical reliability y of these items. In the case of an inadvertent firing of a cartridge or CAD, all contaminated ballistic lines and devices must be replaced because of the corrosive nature of the explosive.

The service life of wire-braid, teflon-lined hoses installed in ballistic applications is the same as that of the aircraft in which it is installed, unless it is used. A hose is considered to be used if the device to which it is attached is fired, either intentionally or accidentally. If this occurs, the hose and related fittings must be replaced. Before you install a hose or fitting (line, T, elbow, etc.), make sure that it is not contaminated by hydraulic fluid, oil, or a similar type of contaminant. All hoses in the escape system must be inspected for accidental damage at every phased inspection, upon seat removal, after removal of any part of the escape system, and for disconnection of any hose.

When CADs are not installed in an aircraft, the inlet and outlet ports must be sealed with protective closures to prevent the entrance of moisture and foreign matter. For shipping purposes, the safety pins and protective closures provided with the replacement CAD must be returned with the replaced CAD to ensure it is in a safe condition during handling and storage. During ejection system maintenance actions, all disconnected CADs and associated ballistic lines must be protected with flexible plastic plugs that conform to MIL-C-5501/l0A and flexible plastic caps that conform to MIL-C-5501/l1. NAVAIR 11-100-1.1 provides information relating to these caps and plugs.

SMDC AND FCDC MAINTENANCE AND INSPECTION REQUIREMENTS

The major components of an SMDC assembly are the stainless steel tubing (SST), outer and inner ferrules, a silicone rubber seal, a 0.004-inch thick SST booster cup, an explosive booster charge, and a sheathed explosive detonating cord. A sectioned drawing of a standard SMDC/FCDC tip assembly is shown in figure 2-19. The SMDC assemblies used in the canopy and hatch severance system are similar in design and construction except for the length and bend configuration of the stainless steel tubing and silver sheathed explosive detonating cord.

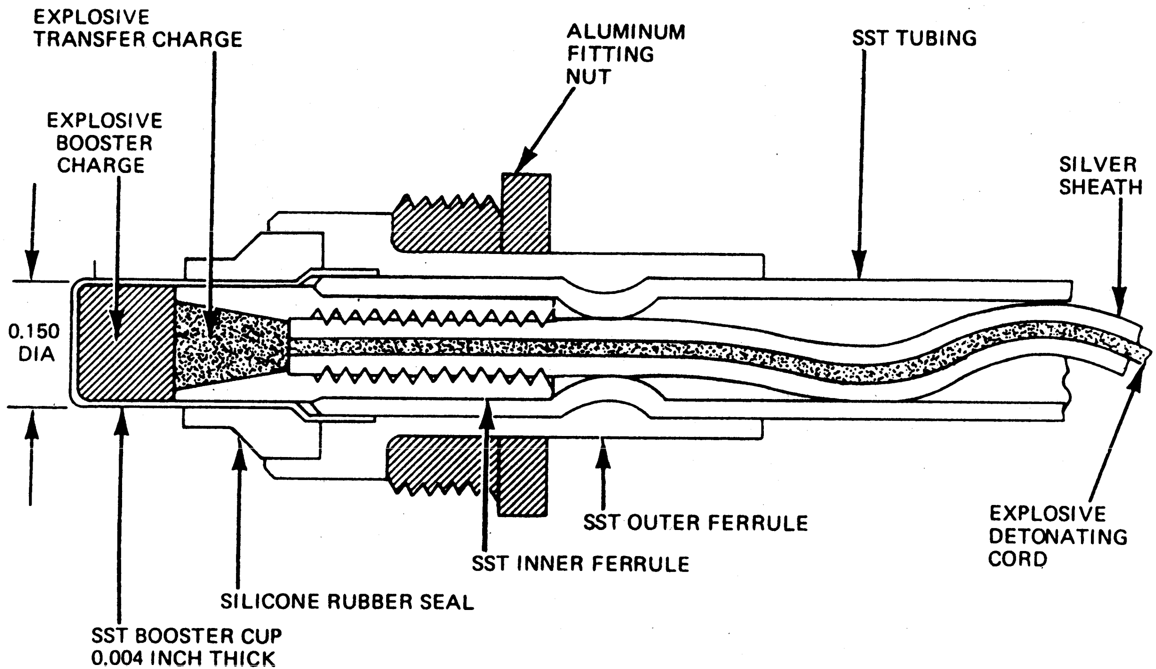

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Figure 2-19.—Standard SMDC/FCDC tip assembly.

To properly inspect SMDCs and FCDCs, you should adhere to the following requirements and precautions:

1. Ensure ground safety devices required during maintenance are correctly installed.

2. To prevent damage to the SMDC and FCDC booster tips, you should use extreme caution during removal and installation. All open connections must be capped with protective covers to prevent damage to SMDC and FCDC booster tips and contamination of open fittings.

3. Inspect each SMDC and FCDC assembly fitting nut for deformation, flattening, or wrench cutting.

4. There must be no corrosion, cracks, discoloration, flatness, gouges, holes, improper bends, kinks, sharp dents, splits, swelling, or wrinkles in an SMDC or FCDC assembly.

5. Smooth dents or slight depressions in SMDC or FCDC assemblies, tubing, or hoses are permitted if they do not exceed specified damage limits (fig. 2-20). If the limits are exceeded, the SMDC or FCDC assembly must be replaced.

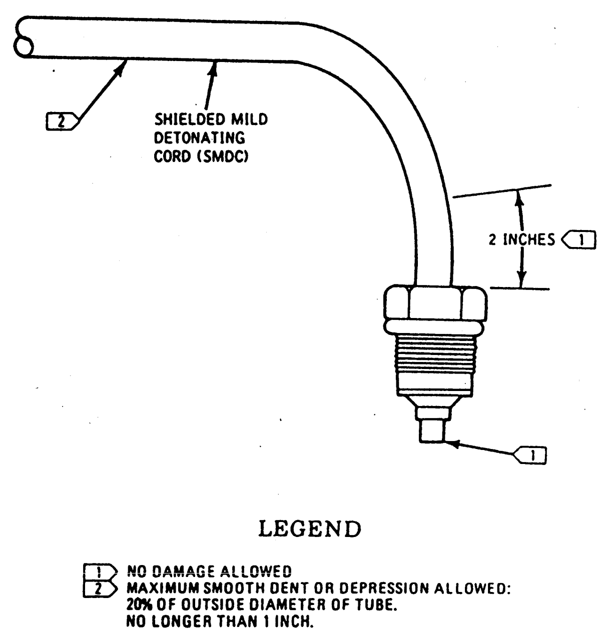

Figure 2-20.—SMDC damage limits.

6. SMDC and FCDC assemblies that do not pass inspection must be replaced. Repair of SMDC tubing is not permitted.

7. Proper clamp spacing (fig. 2-21) must be maintained to prevent damage to SMDCs due to vibration. Improper clamp spacing may result in failure of the SMDC.

SMDC Clearance

Correct clearances must be maintained between SMDCs, SMDC and adjacent structures, and tubing and operating mechanisms. Insufficient clearances may result in damage to or failure of the SMDC. You must ensure SMDCs are installed with proper clearances as listed below:

1. Minimum required clearance between any supported section of SMDC and the adjacent structure is 1.00 inch.
2. Minimum required clearance between any straight, unsupported section of SMDC and an adjacent structure is 0.25 inch.
3. Minimum required clearance between any two parallel SMDCs is 0.10 inch.
4. Minimum required clearance between any two supported nonparallel SMDCs is 0.10 inch.
5. Minimum required clearance between any two unsupported nonparallel SMDCs is 0.10 inch.
6. Minimum required clearance between any supported section of SMDC and any operating mechanism is 1.00 inch.

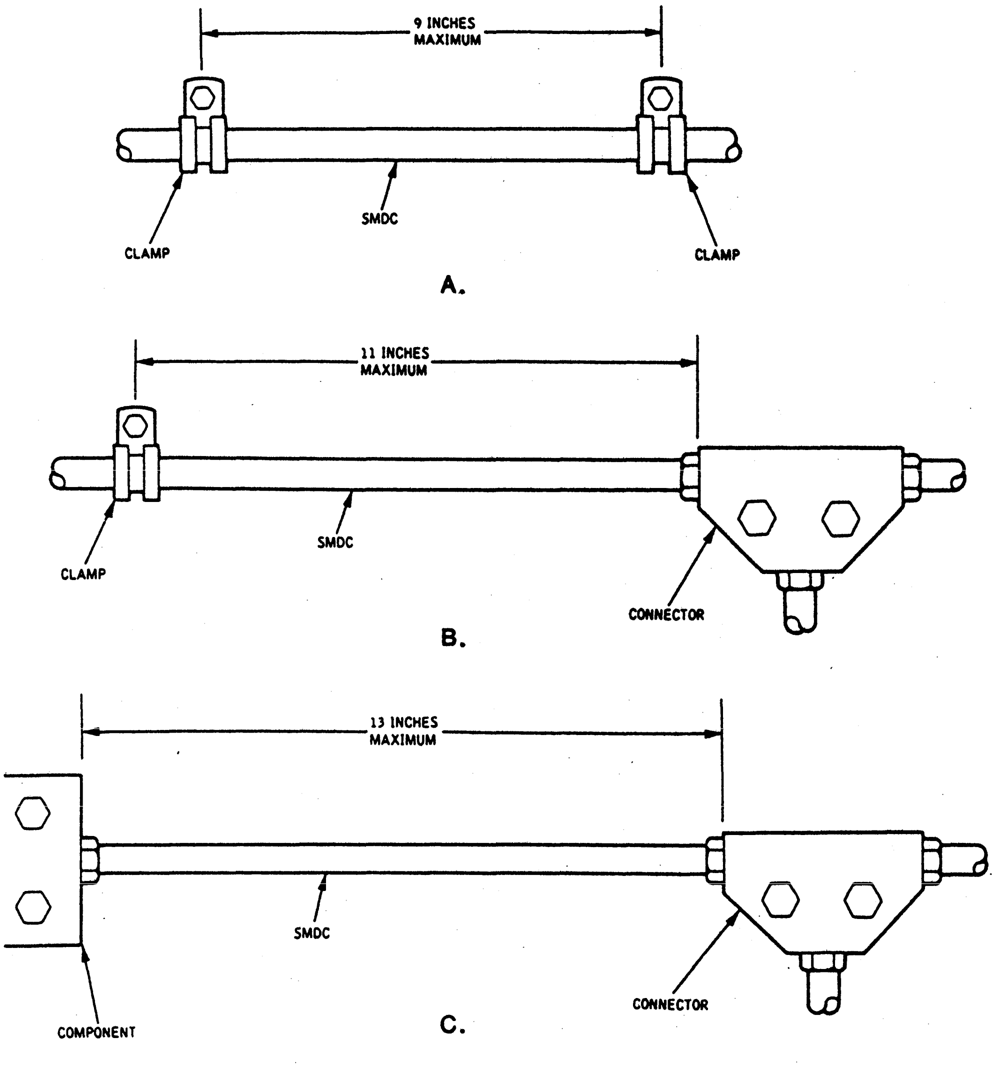

Figure 2-21.—SMDC clamp spacing.

7. Minimum required clearance between any unsupported section of SMDC and any operating mechanism is 1.00 inch throughout the full operating range of the mechanism.

8. Minimum required clearance between any supported section of SMDC and an electrical wire bundle is 0.25 inch, if both are clamped in the same vicinity.

9. Minimum required clearance between any unsupported section of SMDC and an electrical wire bundle is 0.25 inch above the wire bundle or 1.00 inch below the wire bundle.

Booster Tip and Ferrule Inspection

Inspection requirements for SMDC booster tips are as follows:

1. No damage, however slight, is permitted on SMDC or FCDC booster tips or skirted ferrules. If any damage is observed, the SMDC or FCDC must be replaced. Shiny surfaces on booster tips are permitted.

2. If the ferrule is loose or partially swivels, the SMDC or FCDC must be replaced. This may be determined by holding the skirted ferrule and attempting to rotate it radially.

Detonating Cord Inspection Gauge Set

The SMDC or FCDC booster tip must be inspected for correct length and alignment (fig. 2-22). Use the detonating cord inspection gauge set, part number A51562680-1, in the following manner:

1. Use the correct size gauge for booster tip inspection.

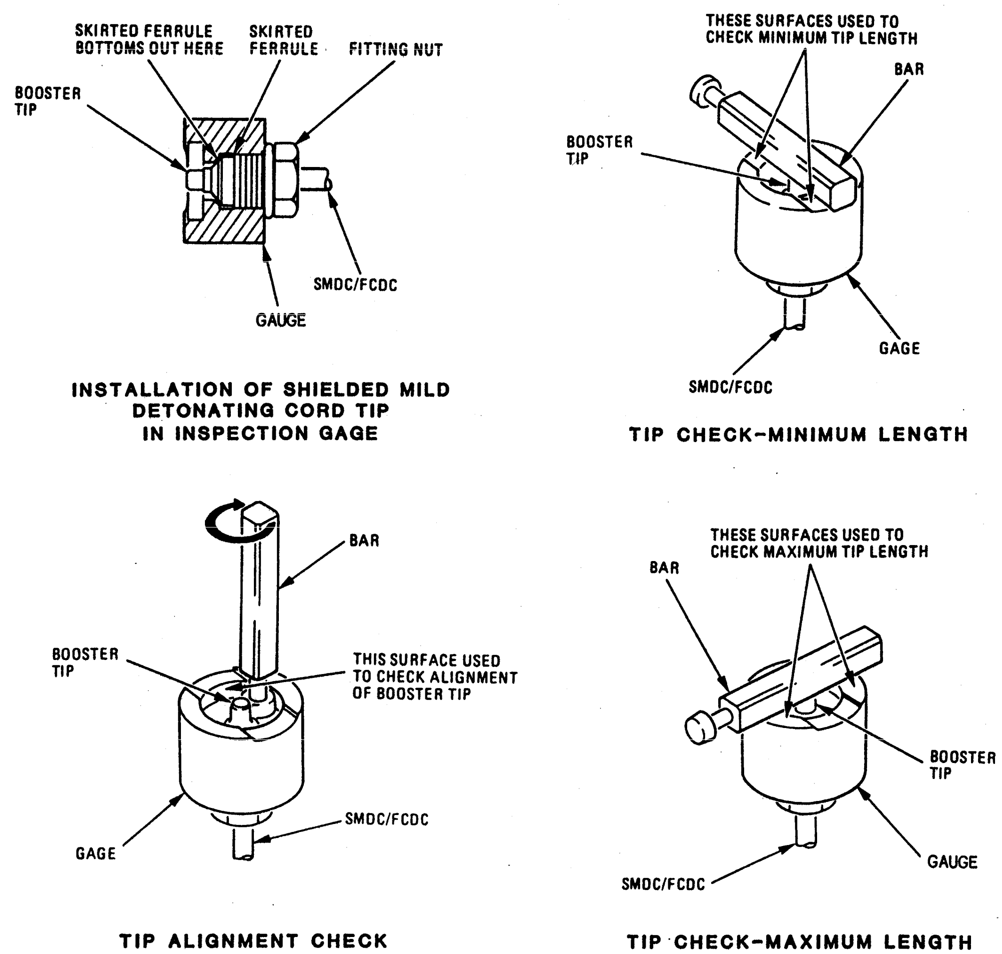

Figure 2-22.—SMDC/FCDC booster tip inspection.

2. Screw the detonating cord inspection gauge onto the fitting nut until the skirted ferrule bottoms in the gauge.

3. Place the flat surface of the bar against the recessed portion of the gauge. If the booster tip is too short, the bar will contact flats on both sides of the gauge. In this case, the SMDC or FCDC must be replaced.

4. Place the flat surface of the bar against the raised portion of the gauge. If the booster tip is too long, the bar will contact the tip and one side of the gauge. Again the SMDC or FCDC must be replaced.

5. Place the cylindrical end of the bar in the space between the gauge and the booster tip. If the booster tip is not concentric within 0.010-inch tolerance in radius, the bar will not pass completely around the booster tip. The SMDC or FCDC must be replaced.

6. If a condition exists that requires the SMDC or FCDC to be replaced, tag it as defective.

Booster Tip Repair

Repair of SMDC booster tips is limited to replacement of packings on the tips and replacement of a damaged seal (fig. 2-23.) The following instructions apply to the repair of booster tips:

1. Visually inspect the seal.
2. If it is damaged, remove the seal.
3. Use a clean cloth moistened with Nozel No. 18 solvent to clean the existing adhesive.
4. Apply a thin coat of RTV-102 adhesive to the inside diameter of the skirted ferrule. Ensure that the adhesive does not come in contact with the booster tip.
5. Install the seal on the tip.
6. Allow the tip to dry and reinstall the SMDC. Tighten the SMDC with your fingers to prevent stripping of the nut.
7. Tighten the SMDC or FCDC fitting nut to the proper torque in accordance with the MIMs and safety it with lockwire.
8. Quality assurance personnel will inspect all SMDC and FCDC fitting nut torquing and safetying.

SAFETY PRECAUTIONS

Cartridges used in cartridge-actuated personnel escape devices must function perfectly the first time. Malfunction of the device, or failure to fire when needed, usually results in severe injury to or death of the pilot and crew member(s), and damage to or destruction of the aircraft.

Cartridges are carefully designed and manufactured, but their performance in cartridge-actuated devices is dependable only when they have been properly handled and installed. Care must be observed to maintain the devices in perfect condition.

Since individual cartridges cannot be tested, the responsibility for proper functioning is in the

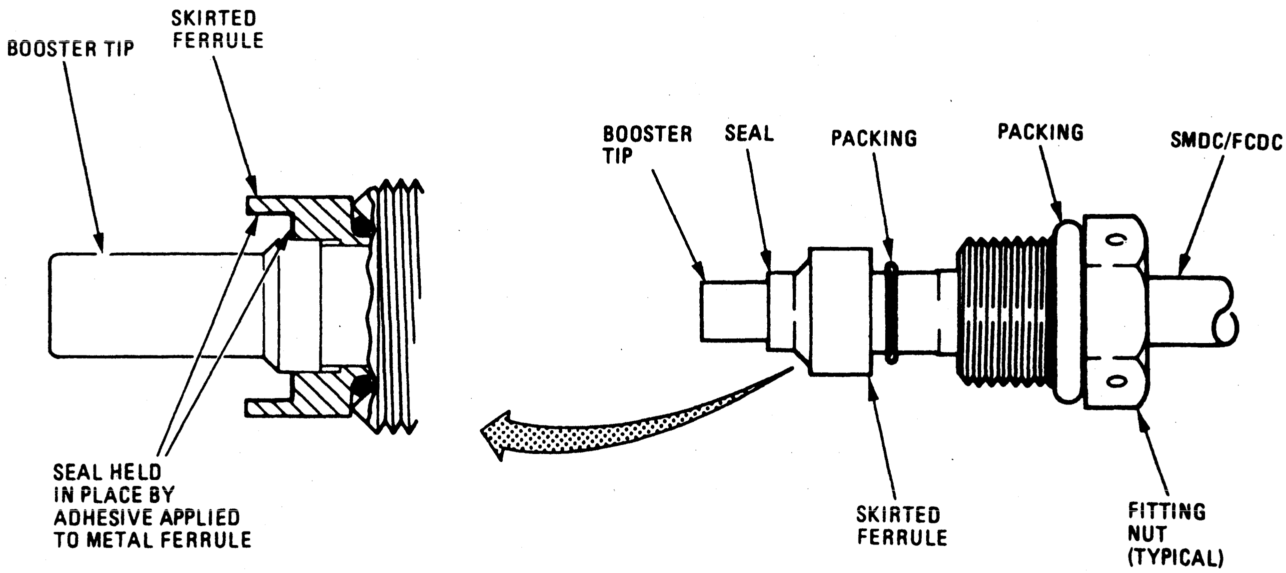

Figure 2-23.—SMDC/FCDC booster tip repair.

hands of the supervisor and the personnel who maintain them. The quality and reliability of an ejection system are largely dependent on the supervisors and the mechanics who maintain the systems. Because the safety precautions presented in this chapter are basic and general in nature, you should consult other publications for the specifics related to the task at hand.

Smoking

Smoking must be prohibited in any magazine, building, vehicle, or other conveyance or area containing explosives or ammunition; where operations involving such material are conducted; and in the immediate vicinity of handling or loading operations involving explosives or ammunition. Smoking areas maybe designated by the commanding officer.

Magazines

Naked lights, matches, lighters or other spark, flame, or heat-producing devices must NEVER be taken or stowed in magazines or other areas containing explosives.

Cartridges

If a cartridge is removed from a cartridge-actuated device, it should be marked for identification so it can be reinstalled in the same device. A deformed or dented cartridge or CAD might not fit properly in the equipment for which it was designed; therefore, in handling, special care must be exercised to prevent them from being struck or dropped.

Assistance

Under no circumstances should any person reach within or enter an enclosure for the purpose of servicing or adjusting explosive equipment without the immediate presence or assistance of another person capable of rendering aid.

Contamination

Operational activities must not apply anti-corrosive materials to CADs. When anticorrosive material is being applied to any item in the vicinity of CADs or associated equipment, every precaution will be exercised to prevent contamination of the CADs or associated equipment. Contamination of CADs can have a detrimental effect on the function of the system.

Shock

Electrically initiated cartridges must be kept away from stray electrical currents. Under certain conditions, dangerous potentials can be stored in circuits after the power source has been disconnected because of charges retained by capacitors. To avoid casualties, you should always disconnect the power source and discharge and ground circuits prior to touching them.

Reporting

All malfunctions, discrepancies, and accidents involving CADs must be reported by message to NAVORDSTA, Indian Head, Maryland in accordance with OPNAVINST 4790.2. If the suspected defect is with the CAD, the message must be addressed to NAVORDSTA for action. If the report describes an inadvertent actuation of an aircraft system resulting in the CAD functioning normally, the action copy of the report must be submitted to the cognizant field activity (CFA) for the aircraft with an information copy to NAVORDSTA, Indian Head, Maryland. Accidents and incidents involving CADS may require reporting in accordance with OPNAVINST 3750.6 in addition to the OPNAVINST 4790.2. Submission of the reports required by the maintenance instruction does not satisfy the requirements of the safety instruction. If dual reporting is required, you should ensure the reports are adequately cross-referenced to satisfy the requirements of all commands involved.

All CADs suspected of being inconsistent, of malfunctioning, or of being involved in an accident or incident must be clearly identified and turned in to the station or ship's ordnance or weapons department. Mark the item "hold for 30 days for engineering investigation (EI) pending disposition instructions." The report should contain the turn-in document number and identify the activity holding the material. If CFA response is requested, NAVORDSTA will respond with complete disposition and shipping instructions. If a response is not received within 15 days, a follow-up message must be sent to NAVORDSTA to verify their receipt of the original report.

All cartridges and cartridge-actuated devices must be handled as live ammunition. Cartridges or cartridge-actuated devices that have been fired may retain an explosive residue capable of presenting a hazardous condition. The ejection seat, parachutes, and survival equipment with installed CADs must be stored and handled by authorized personnel only. They must be stored and handled only in an area designated and approved by the maintenance officer.

Safety devices and pins must be kept in good condition and used only with the individual CAD for which they were designed. When a loaded cartridge-actuated device is not in use, the safety device or pin must be installed. Substitute materials must not be used to replace safety pins installed in CADs. If inlet and outlet ports are present in a CAD, they must be covered with a protective cap. If a protective cap is not available, you should use the shipping cap when the device is not installed.

Except in an emergency and by proper authority, CADs must not be installed in or removed from aircraft during fueling or defueling operations.

CADs installed on or in ejection seats, parachutes, or survival equipment that remain installed during maintenance evolutions do not require removal prior to storage in the maintenance space. CADs removed from ejection seats, parachutes, or survival equipment must be properly safetied and protective caps and plugs must be installed as required. Removed CADs must be stored in a ready-service magazine approved for Class C ammunition storage unless they are required for reinstallation on the same day; in which case, they must be stored in the area approved by the maintenance officer.

Markings

When the sealed inner container of a CAD is opened, all CADs in the container must be stenciled with indelible ink to show the computed container open date and expiration date. Before inserting a cartridge in a cartridge-actuated device, the cartridge expiration date must be checked to ensure the cartridge will not become overage before the next periodic maintenance of the aircraft in which it is to be installed.

Problem Areas

The Naval Safety Center receives messages of interest to AMEs. The following paragraphs contain a few examples of some of the problems that have been received by the safety center related to ejection seats.

Several instances have been reported concerning cartridges stuck in ejection seat systems. This problem is not new, but it still warrants concern as the problem still exists. Some of the causes of stuck CADs are overtorquing during installation, incorrect tools used for removal and installation, and the use of incorrect seals or lubricants. To avoid stuck CADs, you should ensure that correct procedures and parts are used during installation. If correct procedures are followed, the CADs should not stick and removal with the prescribed tool should be possible.

Another message described two ejection seats that required 150 man-hours each to treat for corrosion. This is a tremendous amount of time to spend for corrosion control on ejection seats. If a unit waits until a major inspection cycle to treat a system for corrosion, it will require extensive man-hours to remove corrosive properties that have formed. Most metals will corrode, but the corrosion can be controlled. Remember, the 7-, 14-, and 28-day inspections provide the opportunity to discover corrosive areas and to treat them before they become major problems.

Ejection seats and ejection system components that have been used in an ejection or fired are prohibited from being used to locally construct squadron or unit training services. The policy of the Chief of Naval Operations (CNO) is that ejection seat maintenance and aircrew training will be provided in a formally structured course of instruction.

An aircraft's ejection system is an aviator's last resort to save his/her life when disaster is imminent. The system must be maintained with the highest standards of workmanship possible.

ORDNANCE CERTIFICATION PROGRAM

Learning Objective: Identify the reason for the ordnance certification program.

All personnel involved in the handling, preparation, inspection, or adjustment of live ammunition must be qualified and certified for the task involved in accordance with OPNAVINST 8023.2, as augmented by the fleet commander, type commander, and NAVSEA Instructions. Only reliable, mentally sound, and physically fit personnel will be permitted to work with or use explosives and ammunition. The procedures and circumstances for revocation of an individual's qualification and certification are set forth in OPNAVINST 8023.2.

All personnel must be frequently instructed in the safety precautions, methods of handling, storage, and uses of the ammunition or explosives they handle. No one will be permitted to inspect, prepare, or adjust live ammunition and explosives until the duties, preparations, and hazards involved are thoroughly understood.

Personnel assigned to operate ordnance equipment must receive, prior to commencing operation, a thorough indoctrination in general safety precautions applicable to ordnance and in the specific precautions applicable to the equipment. New or inexperienced personnel must not be permitted to work independently on explosive ordnance of any kind. They must be under the direct and constant supervision of skilled, experienced, and certified personnel until adequate experience is acquired.

Familiarity with any work, even though dangerous, may lead to carelessness. Therefore, personnel who supervise or perform work in connection with the handling, inspection, installation, and care of cartridges must observe the following restrictions:

1. Ensure that all applicable regulations are rigidly observed.
2. Carefully supervise the activities of all subordinate personnel.
3. Inform all personnel of the constant need for using the utmost vigilance in the performance of their work.

AME supervisors that are assigned to commands that handle ordnance or ejection seats should be thoroughly knowledgeable about aircraft logbooks and the aeronautical equipment service record (AESR) of the logbooks. These are covered in the *Aviation Maintenance Ratings 1 & C*, NAVEDTRA 10343, and OPNAVINST 4790.2.

The AME supervisor should keep records of explosive devices and their expiration dates. Some commands incorporate local cards or sheets that include the functional checks, pin protrusions, torque valves, and CDI and QAR requirements. Blank cards or sheets are provided for individuals to sign upon completion. MRC numbers can be incorporated for assignment to ensure that each step is completed before the next step is started. This procedure is advantageous during a shift change or work stoppage.

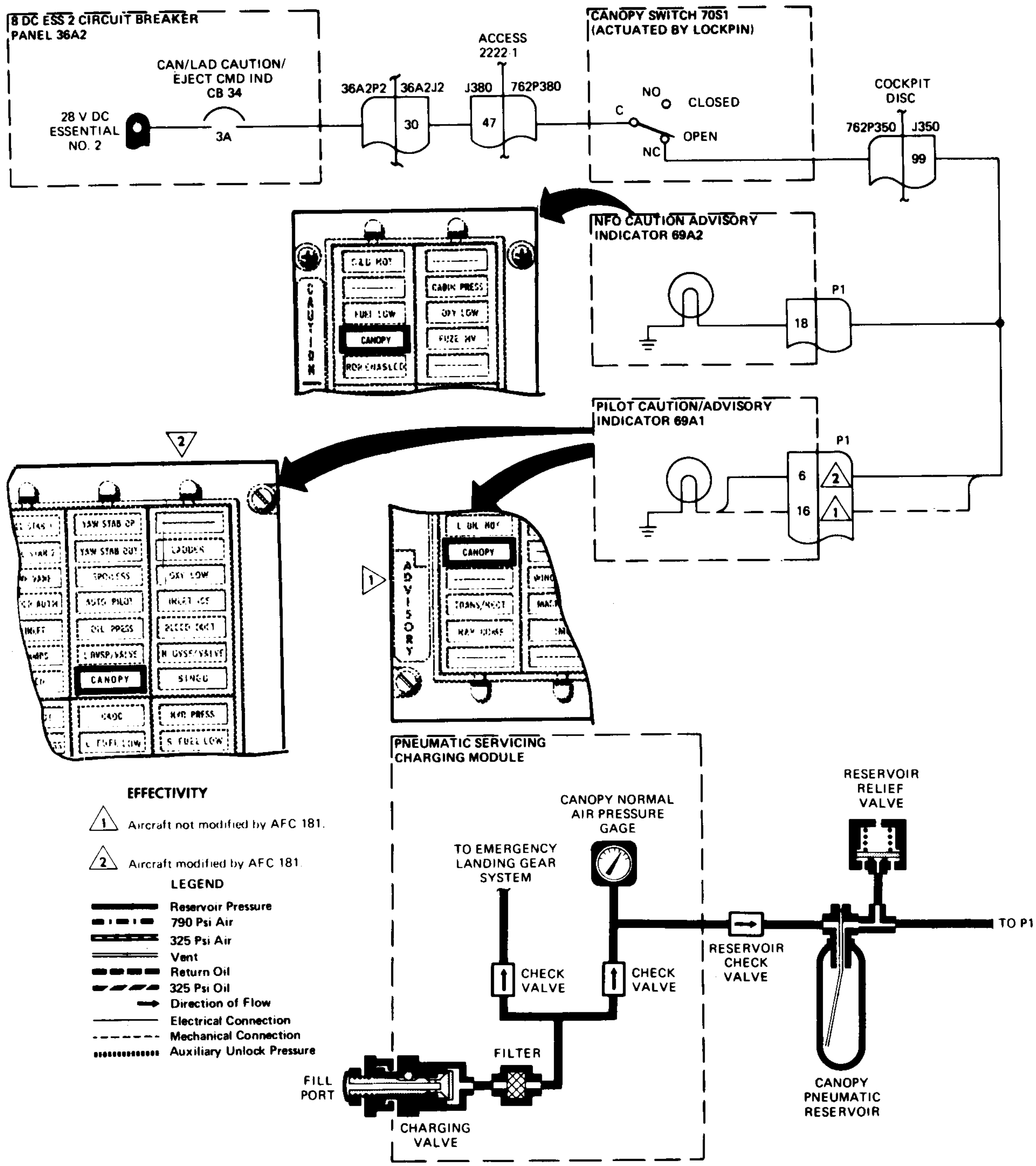

Figure 2-2A.—Pneumatic canopy system (normal opening mode).

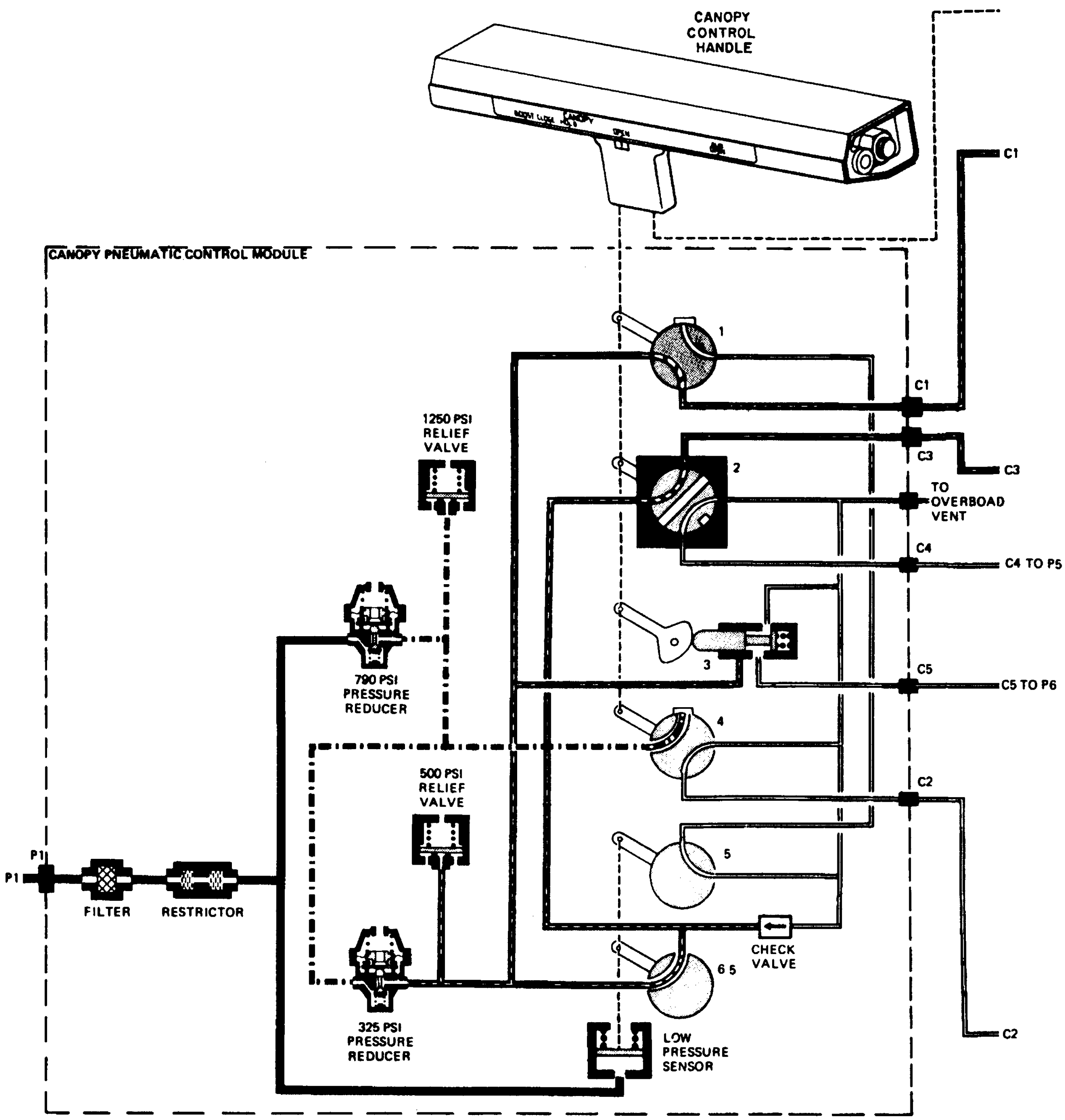

Figure 2-2B.—Pneumatic canopy system (normal opening mode)-Continued

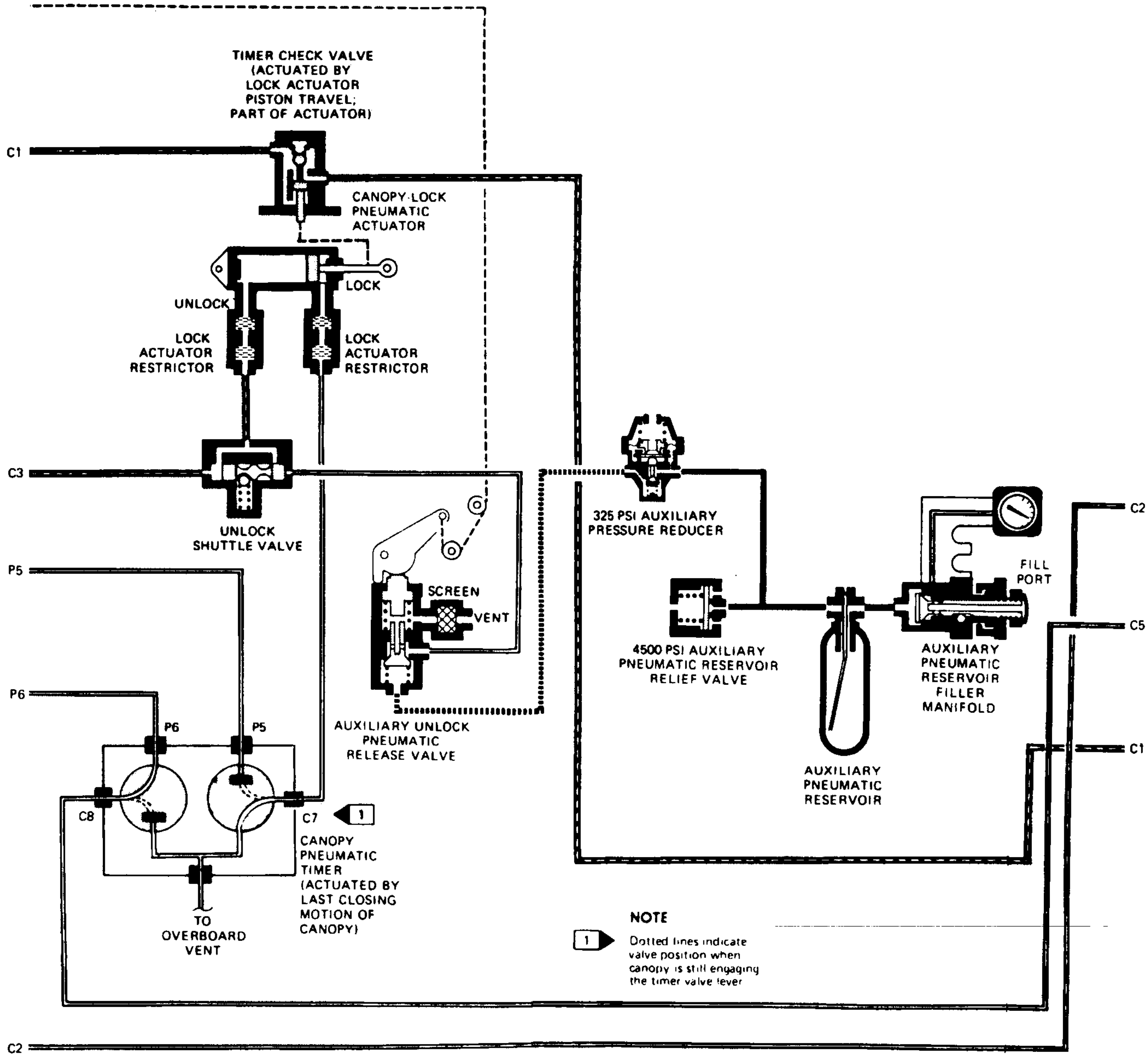

Figure 2-2C.—Pneumatic canopy system (normal opening mode)-Continued

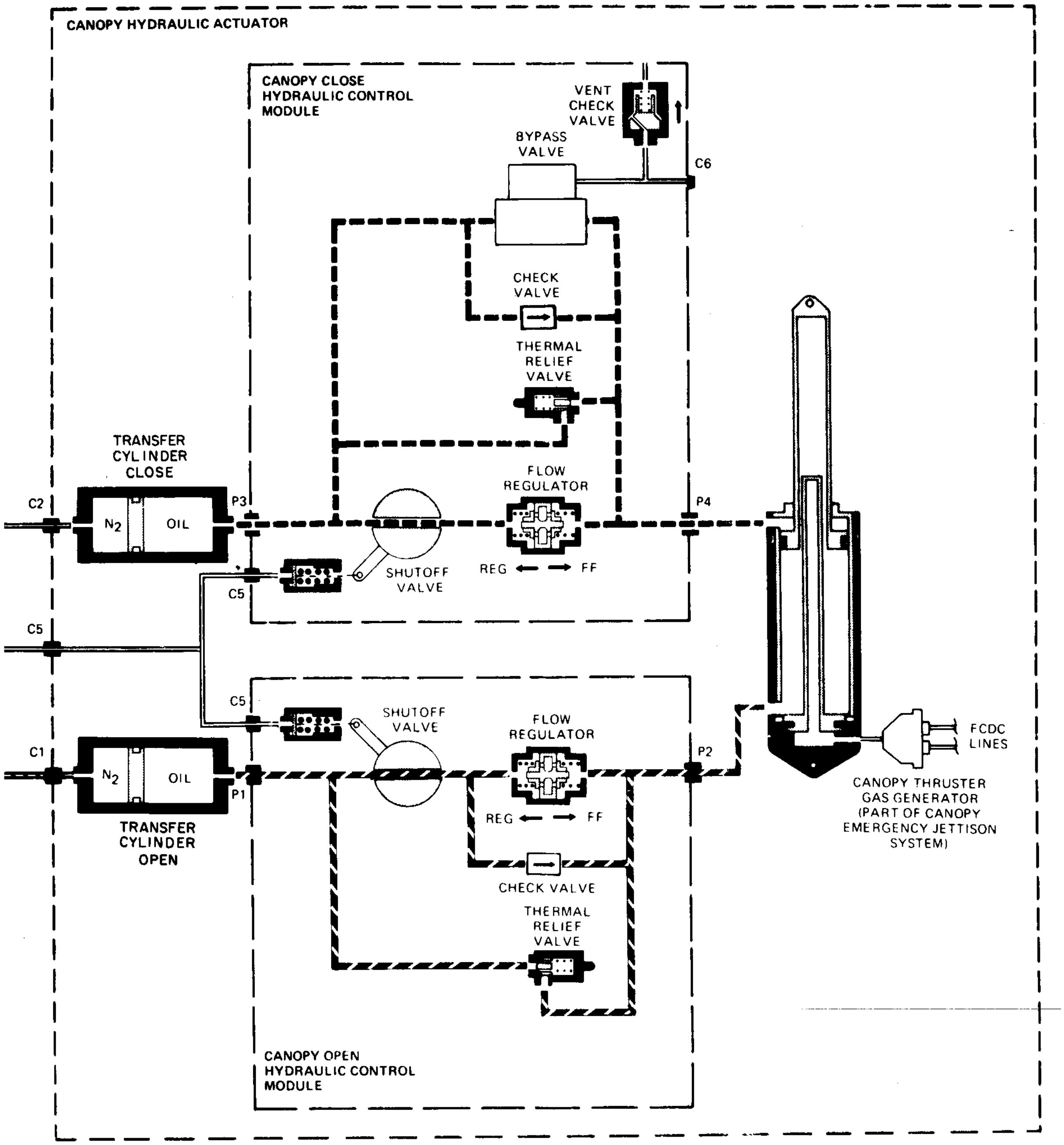

Figure 2-2D.—Pneumatic canopy system (normal opening mode)-Continued